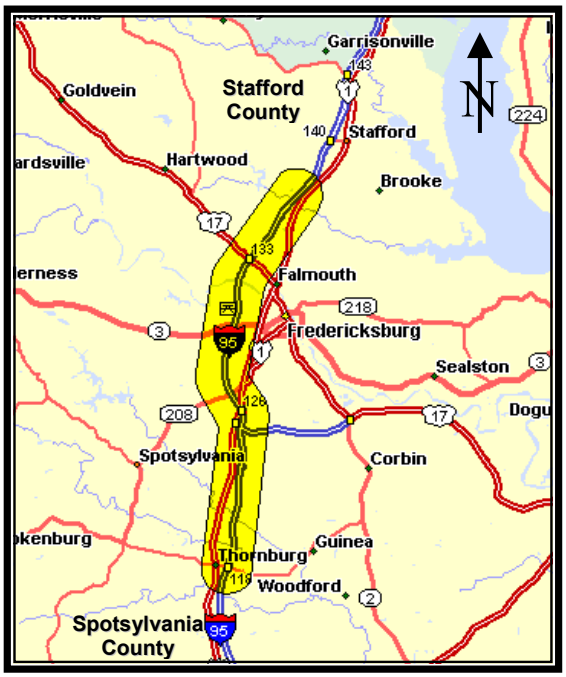
I-95 Collector-Distributor Access Feasibility Study



FINAL REPORT

Prepared For:

Submitted By:

BMI

In Association with:
HNTB, Travesky & Associates, Ltd., Fitzgerald & Halliday, Inc.
SG Associates, Inc., MCV Associates, Inc.

March 2002

I-95 COLLECTOR-DISTRIBUTER ACCESS FEASIBILITY STUDY

Final Report

PREPARED FOR:

VIRGINIA DEPARTMENT OF TRANSPORTATION
Transportation Planning Division

PREPARED BY:

BMI

with

HNTB
Travesky & Associates, Ltd.
SG Associates, Inc.
Fitzgerald & Halliday, Inc.
MCV Associates, Inc.

March 2002

Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration and the Virginia Department of Transportation. The contents of this report reflect the view of the author(s) who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Commonwealth Transportation Board. This report does not constitute a standard, specification, or regulation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background

The objective of this study, which was initiated by VDOT in April 2000, was to examine the feasibility of providing collector-distributor lanes and additional access to Interstate 95 (I-95) in the greater Fredericksburg area. Collector-distributor roads, which are frequently referred to as C-D roads, parallel the interstate and provide access to cross roads while eliminating weaving on the mainline. Currently, there is a C-D road for northbound I-95 at the U.S. Route 17 interchange. C-D roads can be provided at individual interchanges or between successive interchanges.

The study area extends from the programmed interchange near Route 627 in Stafford County to the Route 606 interchange in Thornburg. There are currently four interchanges on I-95 within the 18 mile length of the study area: U.S. Route 17, Route 3, U.S. Route 1, and Route 606. Several roads in this study area cross I-95 without access to the interstate route.

Traffic volumes in the I-95 corridor in the greater Fredericksburg area have increased dramatically over the past 10 years and are expected to continue to increase in the future. For example, the Average Daily Traffic (ADT) on the six-lane section of I-95 over the Rappahannock River has approximately doubled from 65,000 in 1989 to 137,000 in 2000. By the year 2025, the projected ADT is expected to reach 176,000 vehicles per day. Similarly, traffic on the intersecting cross roads and the ramps on and off I-95 within the study area have increased dramatically. Table E-1 presents a partial summary of historical cross road traffic volumes.

Table E-1. Traffic on Cross Roads with Access to I-95 in the Greater Fredericksburg Area.

Cross-Road	Average Daily Traffic (Veh/Day)		Total Increase (Vehicles/Day)	Percent Increase
	1989	2000		
U.S. Route 17 W of I-95	10,310	36,000	25,690	249%
Route 3 W of I-95	30,350	78,000	47,650	157%
U.S. Route 1 S of I-95	15,880	34,000	18,120	114%

Because I-95 access is restricted to a limited number of locations in the greater Fredericksburg area, these interchanges have experienced increased congestion. As volumes increase in the future, congestion will worsen. The provision of C-D roads and/or new interchanges on I-95 would reduce congestion at the existing interchanges by more efficiently distributing traffic on the roadway network.

Study Process

This study employed a two-prong approach. The first was to identify improvements that would be necessary to existing interchanges to accommodate the projected year 2025 traffic at acceptable levels of service in the PM peak hour. The second was to identify the locations and conceptual configurations of new interchanges that would serve the regional demand.

Traffic demand analysis was prepared using the Fredericksburg Area Metropolitan Planning Organization (FAMPO) region transportation planning model for I-95 and crossroads within the study area to determine the most demand-responsive interchange locations. This information was presented to the FAMPO Technical Committee, which served as a study advisory committee. This Committee selected eleven specific scenarios for further analysis. Following preliminary analysis, the Committee decided to carry forward five candidate interchange locations (a new Fredericksburg access between Route 3 and the Rappahannock River, Route 620, Route 208, the Spotsylvania Parkway south of the U.S. 17 Bypass overpass on I-95, and Route 608).

This analysis included individual and combinations of two or more new interchanges, including some that assumed the closure of the existing I-95 access at the U.S. Route 1 interchange. Year 2025 ADT traffic projections were developed and traffic-based measures of effectiveness were calculated. The results were presented to the FAMPO Technical Committee and the FAMPO Policy Committee, and four scenarios were selected for more detailed analysis.

The projected year 2025 daily and PM peak hour traffic volumes were forecasted for the baseline scenario and the four scenarios. These traffic projections were subsequently used to analyze potential improvements to existing interchanges and different conceptual interchange design configurations for each scenario.

Traffic analyses using Highway Capacity Manual methodologies were conducted to determine the projected year 2025 PM peak hour levels of service (LOS) for I-95 mainline segments, merge and diverge points on I-95, and weaving sections on the C-D roads. The PM peak hour was selected as the critical time period because traffic volumes to and from the ramps are higher than the AM peak period.

Construction cost indices were developed to facilitate comparison among alternatives. The construction cost index is based on a weighted combination of new pavement area and bridge structure area associated with each alternative. In addition, first-order estimates of the amount of additional right-of-way required for the new or expanded interchanges were developed. An environmental overview was prepared to indicate previously identified environmental features affecting each scenario.

This study did not involve further analysis of the new Fredericksburg access interchange, since an interchange justification study had been previously completed for that location and submitted to the Federal Highway Administration (FHWA).

Alternative Improvements to Existing Interchanges

A range of options was considered as improvements to the baseline for the existing four interchanges on I-95. Key findings of the traffic and engineering analysis are as follows:

- C-D roads are needed on I-95 between Route 3 and U.S. Route 17. Even under today's volumes, C-D roads would improve traffic flow through this segment of I-95. The traffic projections that traffic congestion problems are likely to occur due first and foremost to

the shear volume of vehicles getting on and off at the two interchanges. The projected demand on several of the existing one-lane ramps will exceed the available capacity. The 2025 traffic projections also indicate that a large number of vehicles access I-95 at U.S. Route 17 and exit at Route 3, and vice versa. In addition, the capacities of the on-ramp from eastbound Route 3 to northbound I-95 and the off-ramp from northbound I-95 to northbound U.S. Route 17 are expected to be deficient for the projected future traffic volumes. Direct-connect ramps will be needed for these movements. Impacts on wetlands, floodplains, historic sites, and other environmental features would need to be addressed in subsequent environmental documents.

- Without improvements, the existing geometric configuration of the U.S. Route 1 interchange will not accommodate the projected 2025 traffic at acceptable levels of service. Provision of dual left-turn lanes on the off-ramp from southbound I-95 and for the movement from southbound U.S. Route 1 to southbound I-95 would help but still not result in acceptable levels of service. Reconstructing the entire interchange, providing loop ramps in all quadrants and C-D roads, would improve projected traffic conditions. There will be right-of-way impacts on adjacent development.

- Route 606 west of I-95 is projected to experience a substantial increase in traffic due to increased development to the west. The Constrained Long Range Plan (CLRP) for FAMPO indicates that Route 606 will be widened to four lanes. Necessary interchange improvements, such as the provision of a new on-ramp in the southeast quadrant to serve the eastbound Route 606 to northbound I-95 interchange and provision of signal control at the two intersections of the off-ramps, will be needed by the year 2025.

New Interchange Alternatives

Analysis of individual interchanges revealed that the greatest benefits in terms of satisfying projected traffic demand resulted from two new interchanges: (1) at the Spotsylvania Parkway south of the existing overpass for U.S. Route 17 Bypass; and (2) a new interchange on I-95 between Route 3 and the Rappahannock River. Consequently, all four of these scenarios assumed the construction of a new Fredericksburg access interchange and the Spotsylvania Parkway interchange. Differences among the scenarios are identified below:

- Scenario E assumed improvements to the U.S. Route 1 interchange.

- Scenario F assumed closure of access at the U.S. Route 1 interchange.

- Scenario G assumed new interchanges at Route 208 and improvements to the U.S. Route 1 interchange.

- Scenario H assumed new interchanges at Route 208 and closure of access at the U.S. Route 1 interchange.

The Technical Committee determined that Scenario E (new interchange at Spotsylvania Parkway and U.S. Route 1 interchange improved) was clearly superior to Scenario F (new interchange at

Spotsylvania Parkway and U.S. Route 1 interchange closed), which was dropped from more detailed study.

Different design options were developed for the three remaining scenarios. A description of Scenarios E, G and H, including key features, construction cost index, traffic assessment and critical assessment is found in Tables 13 through 17 and 19 through 28 in the main report. The key findings of this analysis are as follows:

- At least two of the design options for Scenario E would accommodate the projected 2025 PM peak hour traffic volumes at acceptable levels of service.

- Scenario G is the most challenging scenario in terms of accommodating three full interchanges within a short distance on I-95. Moreover, there are adverse community impacts due to the need to procure additional right-of-way in developed areas within the proposed I-95/Route 208 interchange limits. A large portion of an existing park-and-ride lot in the northeast quadrant of the interchange would be impacted.

- Scenario H is the best scenario in terms of geometric design because of the spacing between the Route 208 and the Spotsylvania Parkway interchanges. However, there may be adverse impacts to local businesses along Route 1 attributable to the closure of U.S. Route 1 interchange with I-95.

Conclusions and Recommendations

Several of the options are feasible from a traffic/engineering/environmental impact perspective and should be advanced for further study. Table E-2 presents a summary of new interchange options recommended for further study. The table shows the estimated acreage that would be required for additional right-of-way. They are based on county-series property maps and an assumption that right-of-way would be required for a distance of 50 feet beyond the edge of the shoulder on all outer ramps. Similarly, the construction cost indices are order-of-magnitude estimates consistent with planning level feasibility analyses and do not include the costs for additional right-of-way. The environmental overview for the new interchange scenario presents information on potentially affected acres of wetlands and floodplains. The next step would require more detailed assessment of the built environment. Finally, the last column of Table E-2 presents a traffic-based measure that indicates daily vehicle travel projected to occur on I-95 and cross road links in the study area that would be beyond LOS D conditions. The higher the number, the worse the traffic conditions are. While the level of analysis involved in a feasibility study does not provide the amount of detail needed to choose the best option, design option E1 is the most promising based on the review of this study's analysis.

Detailed analysis similar to IJS and environmental documentation would need to be completed before any option could be advanced to location/design approval. Costs and funding availability would be major issues in advancing these concepts.

Table E-2. Summary of New Interchange Options Recommended for Further Study.

Scenario	Design Option	Right-of-Way Affected (Acres)	Construction Cost Index[1]	Environmental Assessment- Potentially Affected Area (acres)[2]		Projected Daily Vehicle Miles of Travel* (DVMT) on Over-Saturated Links in the Study Area (1,000 veh-miles/day)
				Wetlands	Floodplains	
Baseline	-	N/A	N/A	N/A	N/A	111
Scenario E	**E1**	93	34	0.3	1.0	56
	E4	152	71	1.3	1.0	56
	E5	141	60	0.4	0.6	56
Scenario G	**G3**	221	99	0.2	0.5	79
	G4	228	99	1.3	1.0	79
Scenario H	**H2**	163	89	0.6	1.0	86
	H3	162	77	-	-	86

N/A- Not Applicable

[1] Construction Cost Index is a measure to assess the relative difference in construction cost between and among alternatives. It is based on a weighted combination of estimated additional pavement and bridge structure areas for each alternative.

[2] Note: Estimates of impacts are not used for engineering purposes. Data sources are of varying accuracy and final impact determinations may be different.

I. INTRODUCTION

Traffic volumes in the Interstate 95 (I-95) corridor in the greater Fredericksburg area have increased dramatically over the past 10 years and are expected to continue to increase in the future. For example, the Average Daily Traffic (ADT) on the six-lane section of I-95 over the Rappahannock River has approximately doubled from 65,000 in 1989 to 137,000 in 2000, which was the latest published year. Data from the Virginia Department of Transportation (VDOT) indicates the ADT was 137,000 in 2000. Figure 1 presents a plot of ADT by year for this section of I-95 (6% annual growth rate). Over the past 20 years, the average annual growth rate in ADT exceeds six percent per year. By the year 2025, the projected ADT is expected to reach 176,000 vehicles per day, which represents an increase of 47,000 vehicles per day compared to the ADT in 1999.

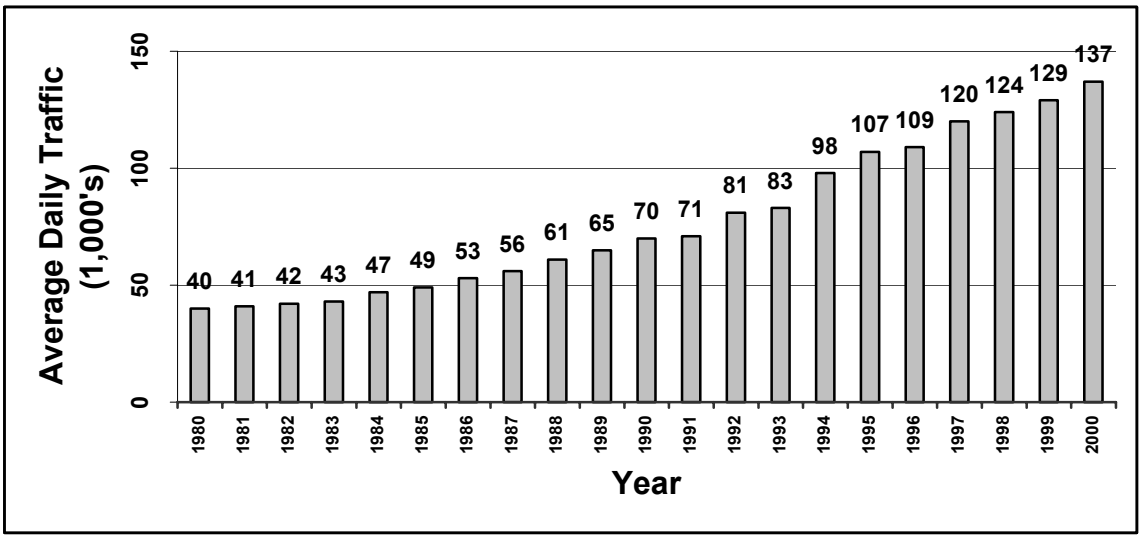


Figure 1. Average Daily Traffic on I-95 between Route 3 and U.S. Route 17.

Because I-95 access is restricted to a limited number of locations in the rapidly growing greater Fredericksburg area, these interchanges have experienced increased congestion. Table 1 presents a partial summary of historical cross road traffic volumes for the three major interchanges serving the greater Fredericksburg area: U.S. Route 17, Route 3, and U.S. Route 1. As volumes increase in the future, congestion in the interchange areas will worsen.

Table 1. Traffic on Cross Roads with Access to I-95 in the Greater Fredericksburg Area.

Cross-Road	Average Daily Traffic (Veh/Day)		Total Increase (Vehicles/Day)	Percent Increase
	1989	2000		
U.S. Route 17 W of I-95	10,310	36,000	25,690	249%
Route 3 W of I-95	30,350	78,000	47,650	157%
U.S. Route 1 S of I-95	15,880	34,000	18,120	114%

Similarly, traffic volumes on the ramps getting on and off I-95 have increased significantly. For transportation planning purposes, travel demand computer models are developed to assess the traffic impacts associated with anticipated growth in population and employment in metropolitan areas. The transportation planning model developed for the Fredericksburg Area Metropolitan Planning Organization (FAMPO) was used to estimate the number of trips on and off I-95 between the programmed new interchange at Route 627 at approximately milepost 136 on I-95 and Thornburg (Route 606, which is signed as exit 118 on I-95). As illustrated in Figure 2, it is projected that the number of vehicles that enter or exit I-95 in this section will increase from 195,000 in 1995 to 375,000 in the year 2025. This represents a projected increase of approximately 160 percent over 30 years.

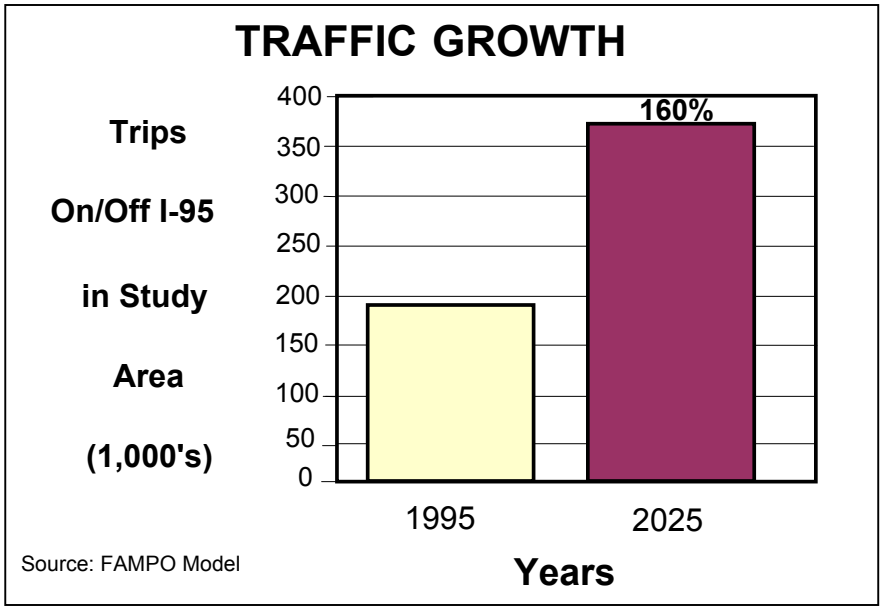


Figure 2. Traffic Growth Between Years 1995 and 2025.

Objective

The study was initiated by VDOT in April 2000. The reasons for the study included the following: 1) to plan for anticipated traffic congestion resulting from growth in population and employment in the greater Fredericksburg area; 2) to improve traffic flow in the I-95 corridor within the study area, especially the traffic flow at and through the existing interchanges; and 3) to provide improved accessibility from the greater Fredericksburg area to I-95, while maintaining the functional integrity of I-95.

The objective of this study was to examine the feasibility of providing collector-distributor (C-D) roads and additional access to I-95 in the greater Fredericksburg area. New interchanges with C-D roads, as well as improvements to existing interchanges were considered. C-D roads run parallel to the interstate mainline and provide access to cross roads while eliminating weaving on the mainline. Typically, they are separated from the mainline by a concrete barrier, although they can be separated by wide grass area.

An existing example of a C-D road on I-95 in the Fredericksburg area is the separate northbound lane between the ramps at the U.S. Route 17 interchange. The provision of C-D roads typically result in improved traffic flow on the freeway mainline, by removing weaving areas and reducing the number of on-ramp merges and off-ramp diverges on the mainline. The benefits from C-D roads can be seen by comparing the northbound I-95 section with the southbound I-95 section at the U.S. Route 17 interchange. Without C-D roads, there are a total of two entrance and two exit points for U.S. Route 17 on southbound I-95. Moreover, weaving between the on-ramp from NB U.S. Route 17 business and the off-ramp to SB U.S. Route 17 business occurs on the freeway mainline. Because of the northbound C-D road, there is only one exit and only one entrance on the mainline of northbound I-95. Furthermore, there is no weaving on the mainline of northbound I-95. This reduces the number of potential congestion points on the mainline, makes it easier for drivers to make route choice decisions, and enhances traffic conditions on the freeway mainline. Merging, diverging and weaving maneuvers can occur more safely at lower speeds on the C-D road, without adversely impact through travel on the interstate. As traffic volumes increase at a location, the benefit of C-D roads becomes increasingly apparent.

It is important to understand that full control of access is required on C-D roads, which are an integral component of the freeway system. Uninterrupted flow must be maintained on C-D roads to operate effectively and avoid impacts to mainline traffic. C-D roads on freeways cannot have at-grade intersections, be they signal-controlled or not. Rather, traffic must merge onto the C-D road from an on-ramp and must diverge from the C-D road onto an off-ramp.

C-D roads can be provided at individual interchanges, such as the case for northbound I-95 at U.S. Route 17, or between successive interchanges, which would be the case for the ultimate design of the new programmed Route 627 interchange in Stafford County, in which C-D roads extend over four miles between the interchange at Route 630 and the interchange at Route 627.

Study Area

The study area, shown in Figure 3, extends from the programmed interchange near Route 627 in Stafford County to the Route 606 interchange in Thornburg.

There are currently four interchanges on I-95 within the 18 mile length of the study area:

- U.S. Route 17, Warrenton Road (which is signed as exit 133 on I-95);
- Route 3, Plank Road (exit 130);
- U.S. Route 1, Jefferson-Davis Highway (exit 126); and
- Route 606, Mudd Tavern Road (exit 118).

Several roads in this study area cross I-95 without access to the interstate, including from north to south:

- Truslow Road (Route 652),
- Fall Hill Avenue (formerly Route 639);
- Harrison Road (Route 620);
- Courthouse Road (Route 208);
- U.S. Route 17, which is also known as the Route 17 Bypass or Mills Drive and is south of the U.S. Route 1 interchange;
- Massaponox Church Road (Route 608); and
- Guinea Station Road (Route 607).

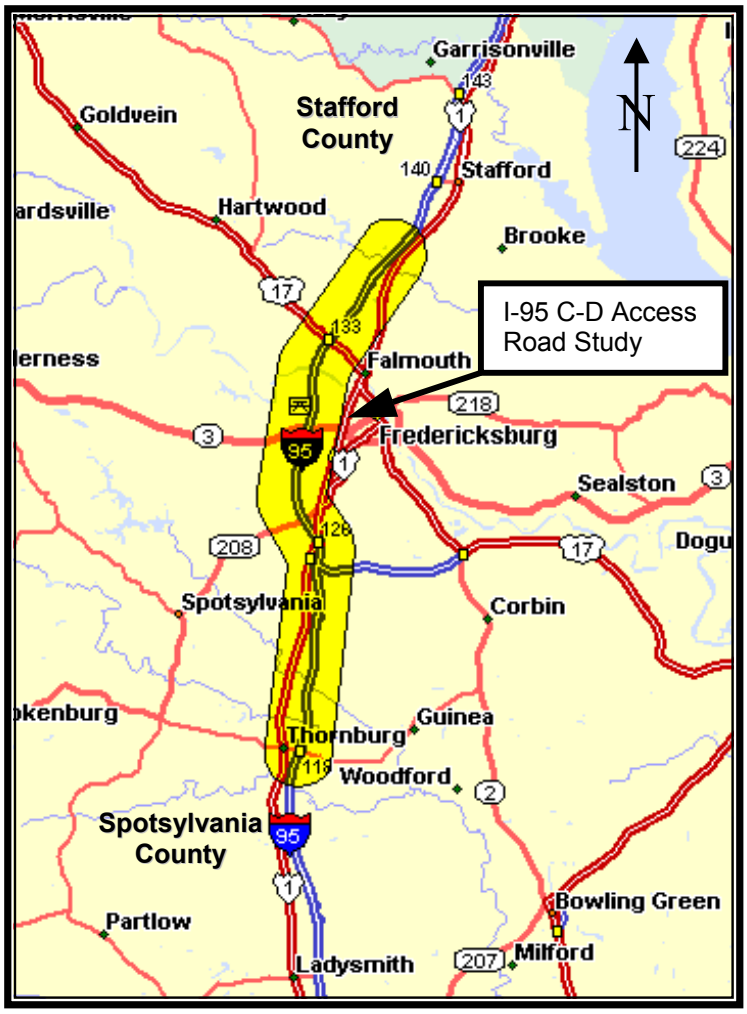


Figure 3. Study Area Map.

The programmed project at the interchange near Route 627 was designed to provide access from I-95 and U.S. Route 1 to the Stafford County Regional Airport, which opened in December 2001. Phase 1 of this project will provide a diamond interchange with direct connections to I-95. The ultimate design will provide a full cloverleaf interchange with C-D roads that extend north to the Route 630 interchange. Construction of the ultimate design will be dictated by future traffic demands. Phase 1 will include the construction of a two-lane roadway from the proposed Airport Connector Road to a new signalized intersection at U.S. Route 1. In its ultimate design, this two-lane roadway will serve as the westbound C-D road. U.S. Route 1 will be upgraded to a six-lane facility with a raised median. The existing Route 627 bridge over I-95 will be demolished and a new, longer bridge will be constructed just south of its present location. The

contract to construct the initial diamond interchange was advertised on October 9, 2001 and is estimated to cost $41 million. Construction is now likely to begin in 2002.

Other Transportation Planning Studies Relevant to the Corridor

It is important to recognize the context of this study, in that there have been several other major transportation planning studies and project planning efforts that have been underway that would affect the I-95 corridor within the study area. Most notable are the two Outer Connector studies.

Northwest Quadrant Outer Connector

A study was initiated on the Outer Connector in the Northwest Quadrant in 1994. The study involved the evaluation of multiple corridors designed to offer an alternative roadway north and west of I-95 and the City of Fredericksburg. The study area is illustrated in Figure 4. The major objectives of the study were to relieve existing and projected congestion on I-95, U.S. Route 17, and Route 3, and to provide access between the growth areas in western Stafford and Spotsylvania Counties. At the Commonwealth Transportation Board (CTB) meeting on October 17, 2001, the CTB selected corridor 1B (see Figure 4) as the Build Alternative for the Northwest Outer Connector. This would connect to the Route 627 interchange.

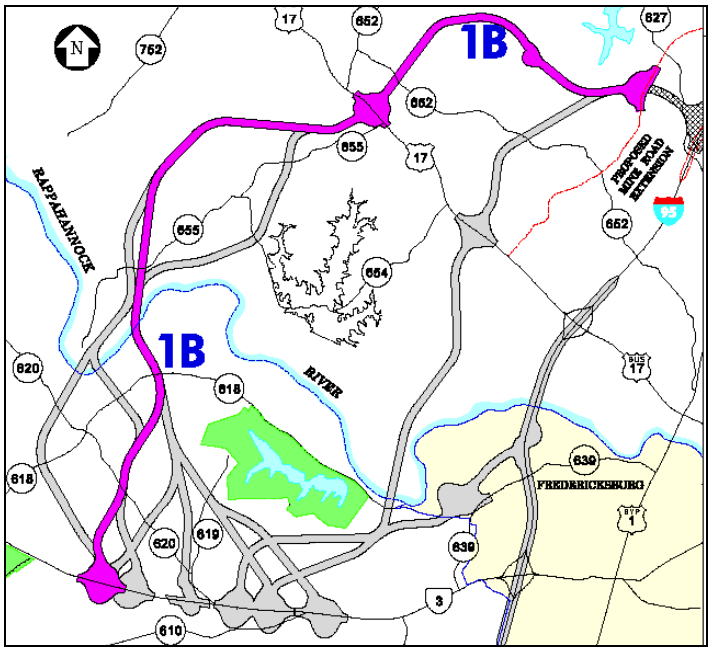


Figure 4. Outer Connector (Northwest Quadrant) Stafford and Spotsylvania.
(Source: Outer Connector SDEIS)

Northeast Quadrant Outer Connector

In March 1998, a major investment study (MIS) was completed for the Outer Connector in the area northeast of the City of Fredericksburg. The study focused on an area that was approximately 25 square miles. The study identified four key needs for improvement:

1. Need to strengthen roadway linkages to provide enhanced regional mobility and accessibility, to connect the study area resident with major activity centers, and to provide for movement through the study area.

2. Need to provide a roadway network that maintains an acceptable level of service while providing for local accessibility and mobility, minimizing congestion, and enhancing safety.

3. Need to promote, to enhance use of, and to interconnect with other modes of transportation.

4. Need to develop a roadway network that serves the existing and future economic development of jurisdictions and localities within the study area.

The major finding of the study was that a new highway facility extending from U.S. Route 1 in Stafford County to U.S. Route 17 Bypass in Spotsylvania County would best satisfy future transportation demand.

Spotsylvania Parkway (Outer Connector Southwest Quadrant)

The Spotsylvania Parkway is proposed in the 2025 FAMPO Constrained Long-Range Plan (CLRP) as part of the circumferential road around the City of Fredericksburg. A four-lane, divided highway from U.S. Route 17 Bypass to Route 3 is envisioned for this facility. According to the CLRP, it would be designed as a controlled or limited access highway with interchanges at Route 3, Route 208, U.S. Route 1, and I-95. The study area is shown in Figure 5. Connections to secondary routes may possibly be designed as at-grade intersections. A location study, including the development of an environmental document, was initiated by VDOT in 2000, and is expected to be completed in 2003.

Celebrate Virginia! Development

In addition, a major development, called *Celebrate Virginia!*, has been proposed for the area west of I-95, and north of Route 3, and the existing Central Park shopping development. As part of that development planning process, an extensive amount of highway analysis was conducted. One of the objectives was to identify an ultimate design configuration that would allow an additional interchange access point to be constructed north of Route 3 and south of the Rappahannock River to serve the proposed tourism campus of the *Celebrate Virginia!* development and provide improved access to the Fredericksburg area. The developer received approval for rezoning along the Fredericksburg side of the Rappahannock River in 2000. That portion of the project calls for hotels, restaurants, museums, retail, and recreational facilities.

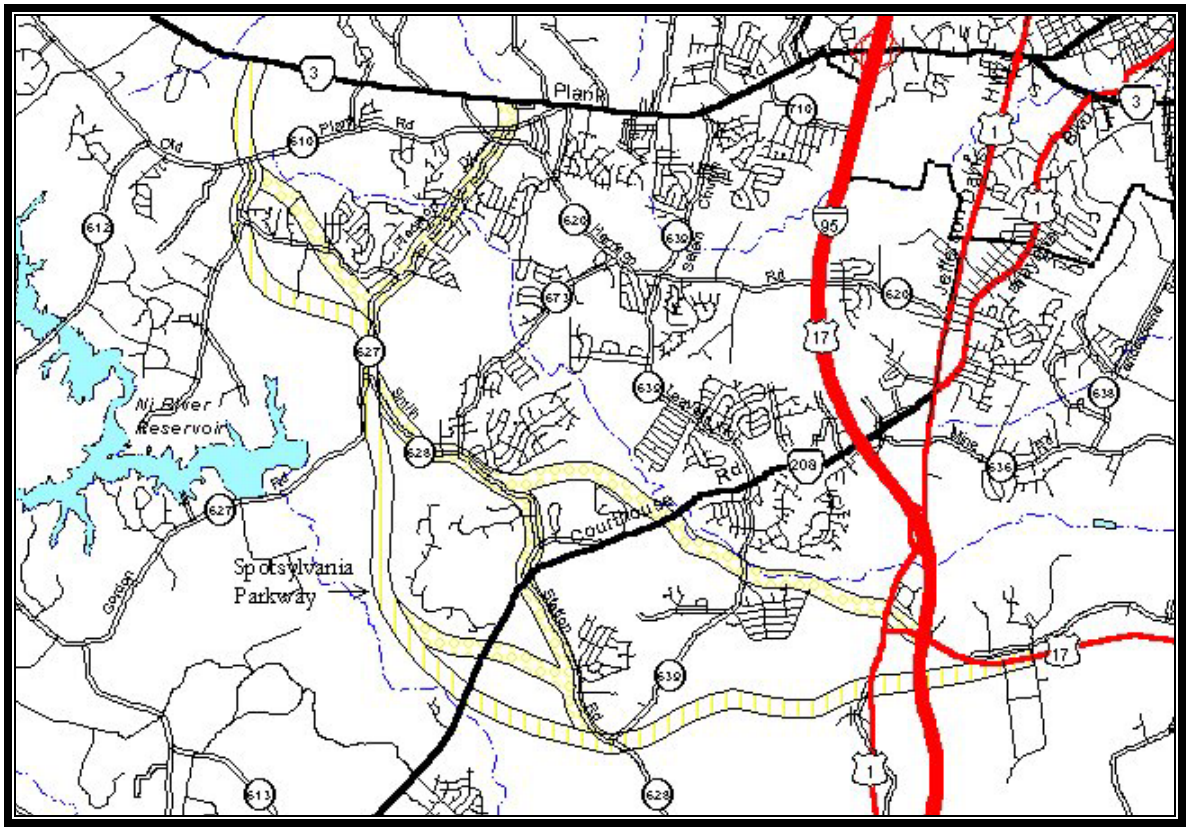


Figure 5. Spotsylvania Parkway (Outer Connector Southwest Quadrant).
(Source: FAMPO CLRP)

In the northern portion of the *Celebrate Virginia!* development, which lies in Stafford County, office development is proposed. An Interchange Justification Study was prepared and submitted to the Federal Highway Administration (FHWA) for review. An IJS is a more advanced step in the interchange approval process and involves much greater level of analysis than this study. FHWA has approval authority on all new access locations and improvements to the interstate system.

Cowan Boulevard Extension

Another project that is underway is the extension of Cowan Boulevard as shown in Figure 6. The project will extend Cowan Boulevard in both directions as a four-lane divided facility, connecting U.S. Route 1 to the east with Carl D. Silver Parkway to the west. The project includes a bridge over I-95 and a multi-use bicycle and pedestrian path on the south side. During the course of the Cowan Boulevard study, the decision was made that there should be no direct access from I-95 to Cowan Boulevard.

Figure 6. Cowan Boulevard Extension.
(Source: virginiadot.org/projects/constfred-cowan-default.asp#)

Fredericksburg Regional Model and Long Range Plan

FAMPO utilizes the VDOT regional transportation model for Fredericksburg to evaluate future transportation and land use scenarios. The initial step in the model development process is the definition of traffic analysis zones (TAZ) and the compilation of population and employment data by TAZ for input into the model. Traffic area zones are relatively small areas bounded by roadways, rivers, or other physical features that separate the movement of vehicles. For data compilation and analysis purposes, TAZs always consist of full census blocks.

In 1999, VDOT staff worked with the FAMPO Technical Committee to update the regional model. In that effort, the TAZ structure was refined from 264 zones to 314 zones, which includes the City of Fredericksburg and the counties of Spotsylvania, Stafford, King George, and Caroline. The base year was changed from 1990 to 1995. The regional model is highway oriented and estimates travel on roadway facilities serving motorized vehicle traffic. The model also considers mode splits for work trips outside the region, recognizing the use of the Virginia Railway Express, commuter bus services, vanpools, and carpools.

The regional model ties transportation and land use together by utilizing population and employment data. Population figures for the base model year of 1995 were obtained from the Weldon-Cooper Center for Public Services. The Virginia Employment Commission (VEC) provided population projections for the forecast year 2025. The 1995 population figures were disaggregated by local planning staff and distributed among the TAZs using 1990 Census Block data and building permit data. The 2025 population figures were also disaggregated by the local planning staff and distributed among the TAZs based on existing development patterns, zoning, and the local comprehensive plans.

Employment estimates for 1995 are based upon VEC employment data, and the 2025 employment is estimated by the respective jurisdictions. The number of employees in each TAZ for 1995 was estimated through the use of this employer data. To determine 2025 employment by TAZ, each jurisdiction's estimated employment was distributed among the TAZs by the local planning staff using existing development patterns, zoning, and the local comprehensive plans.

VDOT's regional transportation model for the FAMPO region generates projections of average daily traffic volumes on the FAMPO roadway networks for year 2025. Within the context of the planning process, transportation modeling identifies capacity deficiencies in the roadway network and quantifies the effects of proposed improvements on the regional transportation system. As such, the model plays an integral part in the project evaluation and selection component of the FAMPO CLRP process. Within the context of this planning process, the objective of the transportation modeling process is to quantify the effects of proposed improvements to the region's transportation system, while establishing the impact of the elimination of certain proposed projects due to financial constraints.

A complete listing and description of projects in the FAMPO 2025 CLRP can be found in Chapter 4 of the CLRP document at *www.fampo.state.va.us*. Table 2 shows major projects in the 2025 CLRP that are particularly relevant to this study. The VDOT regional transportation model used for the CLRP process was also used for this study in order to maintain consistency with the regional travel demand forecasting process and the 2025 CLRP.

Table 2. Major FAMPO 2025 CLRP Projects.

Route Name/ Number	Location	Description
I-95	Route 630	Reconstruct interchange
I-95	Route 627	Construct diamond interchange (Phase I)
I-95	Route 627	Complete interchange and construct C-D roads to Route 630 (Phase II)
I-95	Stafford/ Prince William County Line to Route 610	Extend HOV lanes or widen to eight lanes
I-95	Interchange at Spotsylvania Parkway/ U.S. Rt. 17 Bypass/ U.S. Rt.1	Construct interchange and C-D roads
Outer Connector- NW Quadrant	U.S. Rt. 1 to Route 3	Construct limited access facility
Outer Connector- NE Quadrant	U.S. Rt. 1 to U.S. Rt. 17	Construct four-lane divided facility
Spotsylvania Parkway (Outer Connector- SW Quadrant)	U.S. Rt. 17 Bypass to Route 3	Construct four-lane divided facility

Study Process

This study employed a two-prong approach. The first was to identify improvements that would be necessary to existing interchanges to accommodate the projected year 2025 traffic at acceptable levels of service in the PM peak hour. The second was to identify the locations and conceptual configurations of new interchanges that would serve the regional demand.

The initial step in the study process was to gather existing traffic data that was to be used as a base for existing conditions. A description of the data collection methodology can be found in Appendix A.

The study process consisted of several steps that involved different technical analyses. First, available information on relevant projects and analyses was compiled. On the basis of previous proposals and comments to VDOT, candidate locations for new access (i.e., interchanges) were identified. Using the transportation planning model developed for the FAMPO area and post-processing techniques that will be described in detail in a later section of this report, year 2025 ADT projections were developed for all major roads in the study area corridor, including cross roads. The first set of year 2025 ADT projections was developed for the baseline scenarios, which included planned transportation improvements in the year 2020 FAMPO long-range plan. The land use reflected the latest approved socio-economic forecasts developed for the year 2025. Since a 2025 transportation network had not yet been approved, it was decided to use the 2020 network. One of the major assumptions that affect this study was that I-95 north of Route 3 would be widened to eight lanes, four lanes in each direction. The year 2025 baseline served as the benchmark to which all subsequent projections were compared.

There were two key measures of effectiveness (MOEs) that were identified and used in the comparative analyses. The first was estimating the number of daily vehicle trips entering and exiting I-95 at individual interchanges. This MOE was seen as an important indicator of potential demand at a new interchange: The lower the demand, the lower the need for a specific new interchange. The second MOE was developed to assess the level of congestion resulting from each of the scenarios. It reflected the sum of vehicle-miles of travel on over-saturated links in the study area corridor (defined to include all segments of I-95 and all cross roads within 0.5 miles of I-95). Over-saturated links in the corridor were defined to be those where ADT to capacity exceed 1.0. For this study, capacity was defined to be the "maximum" daily volume for Level of Service (LOS) D conditions, based on assumptions about typical values for directional distribution and k-factor (i.e., percentage of daily traffic in the peak hour).

The next scenario defined includes five new interchanges. After a review of these results, alternatives were identified that assumed one or a combination of new interchanges. The ADT projection on I-95, as well as the cross roads plus the two key MOEs were summarized, presented to, and reviewed by the FAMPO Technical Committee, who served as an advisory committee for this study. With input and guidance from the FAMPO Technical Committee, ADT projections were developed for a total of 11 different scenarios. After review and several presentations, the decision was made to advance four scenarios for more detailed study.

Because traffic flows are higher during the PM peak hours compared to the AM peak hours (i.e., 2 percent higher), the decision was made to analyze specific interchange configurations using year 2025 PM peak hour volumes, which were derived from the ADT forecasts. The study's budget limited the analyses to a one-time period. All of the selected scenarios included the new Fredericksburg access with associated highway improvements and the Spotsylvania Parkway interchange. This was found to have a positive affect in terms of travel on over-saturated links and reduction in volume accessing I-95.

It was properly recognized that a substantial amount of study and analysis had been undertaken on the new Fredericksburg access as part of the developer's IJS. Given that a much greater level of detail had been expended on this new Fredericksburg access, the decision was made to focus the analyses to improved access south of Route 3. Hence, there were no alternative design concepts developed for the new Fredericksburg access. The improvements proposed in the IJS include:

- C-D roads between U.S. Route 17 and road modifications to existing interchanges at Route 3 and U.S. Route 17;

- Two new interchanges on Route 3;

- A grade-separated access into the *Celebrate Virginia!* development site.

For each of the four selected scenarios, design concepts were developed. The concepts involved C-D roads for all new interchanges. For several concepts, C-D roads were extended to include adjacent new or existing interchanges. The objective was to develop a concept that could accommodate the projected PM peak hour volumes at LOS C or better, which is the standard that FHWA uses for interstates in non-urban areas. Under certain extenuating conditions, FHWA may accept LOS D for interchange and freeway improvements.

A representative from FHWA also participated in the early review of design concepts and provided feedback related to the adequacy of concepts in terms of geometry and traffic. In fact, several concepts were dropped because of concerns voiced by FHWA with respect to weaving on the mainline.

After the concepts were identified, they were sketched on the best available digital mapping that could be obtained for the study. The digital maps included various files that were created from aerial photographs taken in 1995. Aerial photographs taken in 1999 were also used during concept preparation.

The concepts were subjected to an engineering assessment, which included the calculation of a construction cost index and estimation of right-of-way areas required. The concepts were mapped on digital photographs. Property maps were obtained from Stafford and Spotsylvania Counties and the City of Fredericksburg. The property maps were used to develop first-order estimates of the amount of additional right-of-way for each of the concepts. For feasibility analysis purposes, a distance of 50 feet beyond the edge of the outside shoulder was used to establish an outer boundary of new interchanges and C-D roads. This simplified approach is

consistent with a feasibility study. More accurate estimation of the additional right-of-way would require the preparation of more detailed design plans, which was beyond the scope of this study.

A construction cost index was computed for each concept. The values were based on order-of-magnitude unit costs from roadway projects. The construction cost index was used to serve as a relative measure of the potential construction cost among alternatives rather than developing an absolute value of construction without the necessary engineering data. The higher the index, the higher the likely cost. For example, if one concept has a construction cost index of 35 and the other has a construction cost index of 70, then the second concept is estimated to be twice as expensive as the first concept. At the conceptual level of detail available, it was concluded that a reasonable estimate of construction cost could not be accurately developed. There was insufficient information on many factors that influence costs, such as amount of cut and fill, retaining walls, additional right-of-way, clearing and grading, maintenance of traffic during construction, lighting, traffic control devices, environmental mitigation costs, utility relocation, and other incidentals.

While detailed environmental analysis was not a part of this scope, the study did involve the identification of environmental features in the proximity of the new interchange locations and the areas impacted by improvements to existing interchanges. There was no environmental fieldwork performed for this study. Rather, the primary sources were known available mapping from other sources, such as the National Wetland Inventory (NWI). Historic structures and environmental features that may be impacted by the concepts were identified. While a preliminary estimate of the acreage of wetlands and floodplains that may be impacted for each concept was developed, a more detailed environmental analysis is required before these concepts can be advanced.

A public involvement program was developed to inform the public about the study and, more importantly, to solicit their opinions and input on new and improved access to I-95 in the greater Fredericksburg area. The joint public involvement program was developed for both this study as well as another study of the feasibility of extending HOV facilities from the Stafford-Prince William County line to Route 3. Both studies were conducted by the same consultant as part of one contract with the Virginia Department of Transportation.

The public involvement program included a public information meeting that was held in the VDOT Fredericksburg District Auditorium on July 27, 2000. During that meeting, candidate locations for potential new interchanges to be considered in this study were shown on aerial photographs, as well as other information, such as historical ADT flows on I-95. A second public information meeting was held on October 29, 2001. During this meeting, the findings of the two studies were presented. A summary of the citizen comments is included at the end of this report.

Organization of the Remainder of this Report

The remainder of this report is organized as follows. Section II presents a discussion of the projected year 2025 traffic conditions for the baseline scenario. The baseline scenario reflects

planned improvements that have been identified in FAMPO's CLRP. These are improvements that are assumed to be completed and in place by the year 2025, and include the assumption that I-95 north of Route 3 would be widened to eight lanes, four in each direction. This section describes the travel forecasting procedures and presents the projected year 2025 ADT, PM peak hour volume and PM peak hour LOS estimates for roadway links in the corridor.

Section III describes the analysis of potential improvements to existing interchanges. For these, it was assumed that there would be no new interchanges on I-95 within the study area limits except for the Route 627 interchange, which will be under construction by 2002.

Section IV describes the analysis of potential new interchange locations and design configurations for those interchanges. This section includes a discussion of a screening analysis of candidate scenarios involving one or more new interchange locations on I-95 within the study area limits. Section IV also discusses the new Fredericksburg access and how a separate IJS has advanced the planning of such an interchange beyond the limits of a feasibility study such as this. There are far more detailed traffic operational analyses and cost-benefit analyses that are associated with interchange justification studies compared to feasibility studies. A feasibility study can be considered the first step in the process of gaining approval for new access on the interstate system. Section IV concludes with a detailed discussion of the alternative scenarios studied in greater detail.

The conclusions and recommendations of the study are presented in Section V. Section VI presents a summary of the comments received at and for a 20-day period following the October 29, 2001 meeting.

Three appendices are included at the end of this report. Appendix A presents the summary results of the traffic volume data collection. Appendix B provides traffic projections for year 2025. Appendix C includes a series of 11" x 17" drawings depicting the scenarios.

II. FUTURE 2025 BASELINE TRAFFIC CONDITIONS

Baseline Scenario

The 2025 baseline network reflects the 1995 base network plus all new construction and the highway improvements contained in the current FAMPO 2025 CLRP. The model's zonal configuration remains the same, but with 1995 zone level land use data updated to reflect planned future land use for the year 2025.

The 2025 baseline scenario has I-95 coded with four general use lanes in each direction north of the Route 3 interchange. South of this interchange, the network has three general use lanes in each direction. C-D roads are included between the proposed Route 627 interchange and the Route 630 interchange. Under the baseline scenario, there are a total of five interchanges in the study area, including programmed Route 627, U.S. Route 17, Route 3, U.S. Route 1, and Route 606. Potential new interchanges for the Spotsylvania Parkway and the new Fredericksburg access were not in the baseline network, but were included in some of the future build networks.

The Spotsylvania Parkway is coded as a major arterial with two lanes in each direction. At Route 3 to the west of Fredericksburg, the Northwest Quadrant Outer Connector crosses over the Rappahannock River. The Northwest Outer Connector is coded as two lanes in each direction, with the facility type being coded as a freeway from north of Route 3 to the planned Mine Road extension in Stafford County. The planned Mine Road extension is listed as a new road running parallel to the west of I-95 between the interchanges at the Northwest Outer Connector and Route 630. The facility is coded as a major arterial. To the east of I-95, the connector is renamed the Northeast Outer Connector, and is coded as a minor arterial with two lanes in each direction. It continues south around the City of Fredericksburg and intersects with the U.S. Route 17 Bypass. The U.S. Route 17 Bypass continues west and intersects with the Spotsylvania Parkway. The U.S. 17 Bypass is coded as a minor arterial with one lane in each direction. The planned network provides a circumferential roadway to serve the urbanized Fredericksburg area. This effectively removes traffic from I-95 in the study area, particularly traffic entering and exiting the interstate (i.e., ramp traffic).

There is also a new road, the "Parallel facility to I-95", as referred in the 2020 FAMPO CLRP, assumed to run parallel to the west of I-95 between U.S. Route 1 and Route 3. This facility is coded as a major arterial and has two lanes in each direction. The addition of this road supplies added capacity to accommodate short trips in the I-95 corridor south of Route 3, and improves the mobility of trips in the surrounding area.

In terms of land use assumed in the 2025 baseline model, Figures 7 and 8 show projected household and employment growth areas in the FAMPO region. As shown, 1995 to 2025 growth in households and employment is largest along the I-95 corridor.

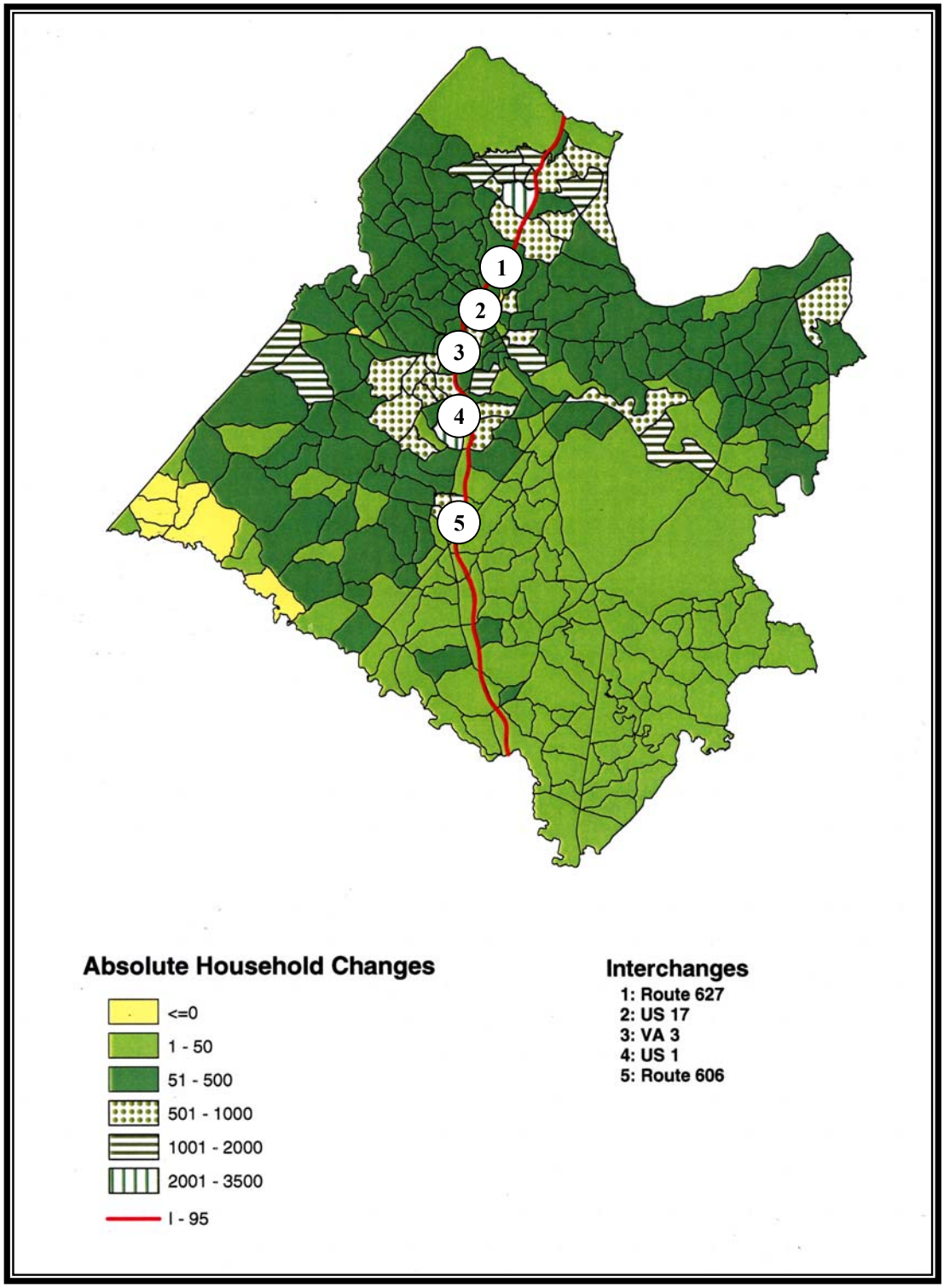


Figure 7. Projected Growth in Households, 2000 – 2025.

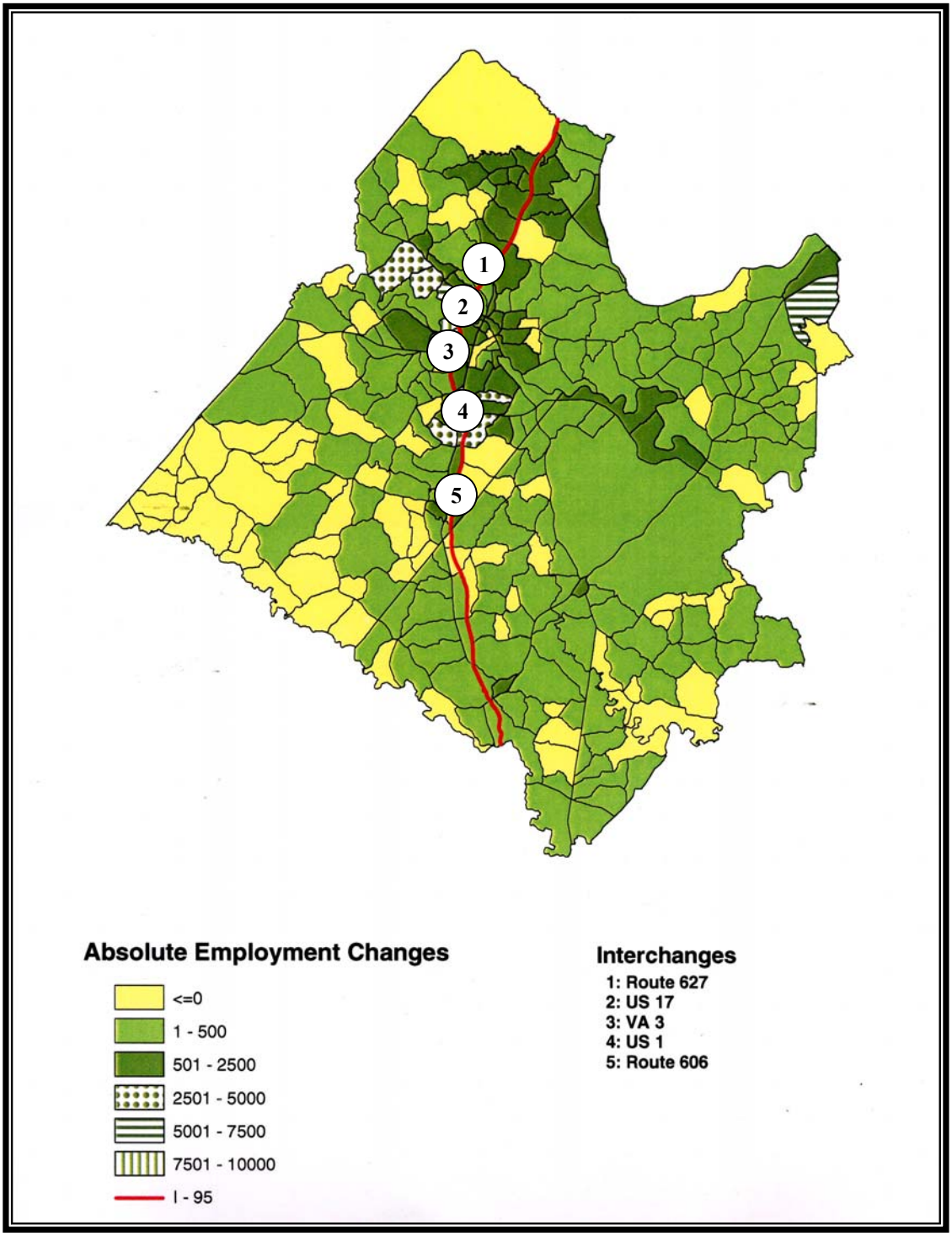


Figure 8. Projected Growth in Employment, 2000 – 2025.

Travel Forecasting Procedures

The travel demand forecasting model is composed of four basic steps: trip generation, trip distribution, mode choice, and assignment. The VDOT model used for this study, which was developed/maintained by VDOT, was recently calibrated for the year 1995, and reflects travel characteristics and patterns for that year. The VDOT model forecasts vehicle trips at the daily level, with travel demand specified in terms of ADT. The benefit of developing travel demand in terms of ADT is that household activities generally begin and end in a given day. Modeling a full cycle of activities is easier, and can be more accurately understood and evaluated.

Trip generation is the first step in the modeling process and involves determining how many trips will be produced and attracted to a specific zone based on a predetermined land use. There are two elements to the trip generation model – trip production and trip attraction. The trip production model used in this case is a cross-classification person trip production model. The trip attraction model is based on a set of linear regression models. The trip production model focuses on household characteristics, including auto ownership, while the attraction model is dependent on employment. The model develops trips for five separate trip purposes: home-based-work (HBW), home-based-other (HBO), non-home-based (NHB), internal-to-external (I-X), and external-to-internal (X-I). External-to-external (X-X) trips, or through trips, are derived by evaluating changes in regional demographics and economics and applying those changes to the existing X-X trip table.

A standard gravity model was used for the trip distribution step. This type of model uses the relative attractiveness, in terms of time, between zones to determine the distribution of trips. The trip distribution model develops an origin-destination (O-D) pair for all zone interchanges by trip purpose. The trip generation data is balanced and then serves as an input into the trip distribution model. The trip tables are developed separately for each trip purpose. The 2025 Fredericksburg regional model does not include the Washington, DC metropolitan area. This area is represented by external zones, but serves as work destinations for many FAMPO residents. Therefore, in the FAMPO travel demand forecast model, external trips are an important factor, and have a greater effect on the forecast travel patterns than in other similar regional models. This is directly related to the type of communities in the FAMPO area and the dominance of the Washington Metropolitan Area. This is a different situation than is found in most regional travel demand models where the external zones do not have such impact on the final results because the dominant city core area is within modeled area. The model utilizes a 1999 O-D survey to estimate and distribute external trips to internal destinations in the FAMPO region.

Currently, there is not a mode choice module being utilized in the FAMPO regional travel demand model. Transit modeling is accomplished off-line in a separate procedure. The person trip tables that are produced from the trip distribution step are converted to vehicle trips based on a set of auto occupancy factors derived from the census and other data. There are unique factors for each trip purpose.

The assignment step involves taking a trip table, which represents O-D pairs, and determining the path of the trips. The assignment model is based on an equilibrium process that spreads trips

evenly across competing routes based on time impedance. The routine repeats until it approaches closure, at which point the network is said to have reached "equilibrium".

Due to the corridor-specific focus of this study, a set of externally-applied post-processing techniques was applied to derive 2025 traffic volumes for the study analysis. Post-processing techniques are generally applied to compensate for inconsistencies in the network and the assignment algorithms of travel demand models. Typically, direct results from the model assignment are referred to as "raw" results. After post-processing techniques are applied, the results are referred to as "refined".

Roadway networks are represented in the model as nodes and links. In the FAMPO model, the nodes serve to attach the links, and are not coded with any specific intersection characteristics. The links are coded with a set of attributes that represent specific roadway segments. These attributes include speed, capacity, and distance.

The techniques that were used to post-process the 2025 model results are outlined in technical report NCHRP-255 *Highway Traffic Data for Urbanized Area Project Planning and Design*. The first step of the post-processing technique is to refine link volumes. The model produces ADT link volumes, which are refined using a worksheet that is outlined in NCHRP-255. The worksheet has two components. The first component addresses model bias as compared to the calibration year. The second component addresses capacity elements, and effectively redistributes link volumes over competing, less-congested parallel routes. The purpose of the second component is to address biases in the assignment algorithm. Competing routes are defined using guidelines listed in the report. Cutlines are then developed, based on the final data needs for design purposes. For a freeway facility, cutlines will need to be defined between each interchange, since refined volumes will be required on each freeway link. For a series of arterials and collectors, the number of cutlines is not so easily defined and differ depending on the data output requirements.

After refined year 2025 ADT volumes were produced, the ADT turning volumes were calculated using procedures outlined in NCHRP-255 Report. The turning movements taken directly from travel models are usually not representative of the actual volumes. This is directly related to the reasons stated above concerning inherent limitations of model networks. For this project, the approach to calculating turning movements was to do so at the ADT level. This assumed that in a day, trips would return on the same path they took going out. Therefore, ADT turning movements had to be equal: what went in, had to return. The turning volumes were balanced as a function of the approach volumes for all intersections.

2025 PM peak hour volumes were developed based on the relationship of the peak hour directional volume to the directional ADT traffic. This relationship, which was derived from existing count data, served as the basis for the derivation of the peak hour. Further refinements were made to balance the percent of the peak hour on the freeway by adjusting the peak hour to ADT percent for each ramp movement. Since freeway peak hour to ADT characteristics are readily known from available data and easily evaluated, the ratio of freeway segment peak hour directional percent to directional ADT volume served as the guide for adjusting the ramp factors.

The next step was to determine if there would be additional spreading of the peak period traffic flows during the peak period. Due to the large volume of commuter traffic, there are periods during the weekday AM and PM periods when traffic volumes are higher than other times of the day. In general, most of the commuter trips are made over a three-hour period in the morning and over a three-hour period in the evening. For some roads that do not experience recurrent congestion, the traffic volume during the peak hour is much higher than the traffic volume during the hour immediately before and immediately after the peak hour. Traffic volumes for these roads during each of the peak hours are on the order of 10 percent of the Average Daily Traffic (ADT) flow and may be as high as 12 to 15 percent of the ADT flow. In urbanized and heavily developed areas, roads generally experience more congestion. Many are characterized by fairly consistent volumes across daylight hours. For these roads, the peak hour traffic volume is not substantially different from the volumes for the hours immediately before and after the peak hour. Traffic volumes during the morning and evening peak hours are typically 8 percent or less of the ADT flow and the peak period traffic is more evenly distributed across the entire three hour morning and evening periods. Based on current traffic data compiled and collected for this study, the ratio of the current PM peak hour volume to ADT daily traffic flow is on the order 7.5 to 8.5 percent for the segments of I-95 and the intersecting cross roads, notably U.S. Route 17, Route 3, and U.S. Route 1. Thus, these major highways have already experienced a spreading of the peak. Consequently, the assumption was made that the existing ratio of peak hour to ADT was sufficient for estimating projected year 2025 PM peak hour directional and turn movement volumes from the projected year 2025 ADTs.

Development of the 2025 PM peak hour projections took the directional ADT volume at the beginning of the study section and applied the peak hour percent to get the in-flowing peak hour volume. Since the peak hour percents along the study segments had been calculated, ramp peak hour factors could be adjusted to produce the expected mainline volume. It should be noted that the PM period used in this analysis is a typical weekday and not necessarily the highest volume conditions, as may occur in the Fredericksburg area on a Friday, Saturday, or a major holiday.

Average Daily Traffic Forecasts for 2025

Figure 9A presents the current ADTs, which are shown for comparative purposes, and Figure 9B presents the 2025 ADT forecasts that were the product of the procedures described in the previous section. The numbers shown in bold are the total non-directional ADT forecasts for each segment between adjacent interchanges. The numbers shown in each quadrant of each interchange represent non-directional ADT turning movements. For example, at the Route 627 interchange, the number 32,800 represents the total daily number of vehicles that will be traveling from westbound Route 627 to northbound I-95 and from southbound I-95 to eastbound Route 627 (i.e., the reverse movement). These daily turning volumes are used to project peak hour ramp volumes on and off I-95 in each quadrant of an interchange.

By 2025, traffic volumes on the I-95 mainline are projected to grow by 75 to 85 percent over existing volumes throughout the study area corridor. While traffic on I-95 is a function of both through and local traffic, traffic on the crossroads is more a function of local traffic generated by proposed land uses in the FAMPO area. Completion of the Outer Connector, which is assumed in the analysis, will serve to divert trips destined for U.S. Route 17 and Route 3 west of I-95; however, completion of the *Celebrate Virginia!* project will result in a significant influx of trips

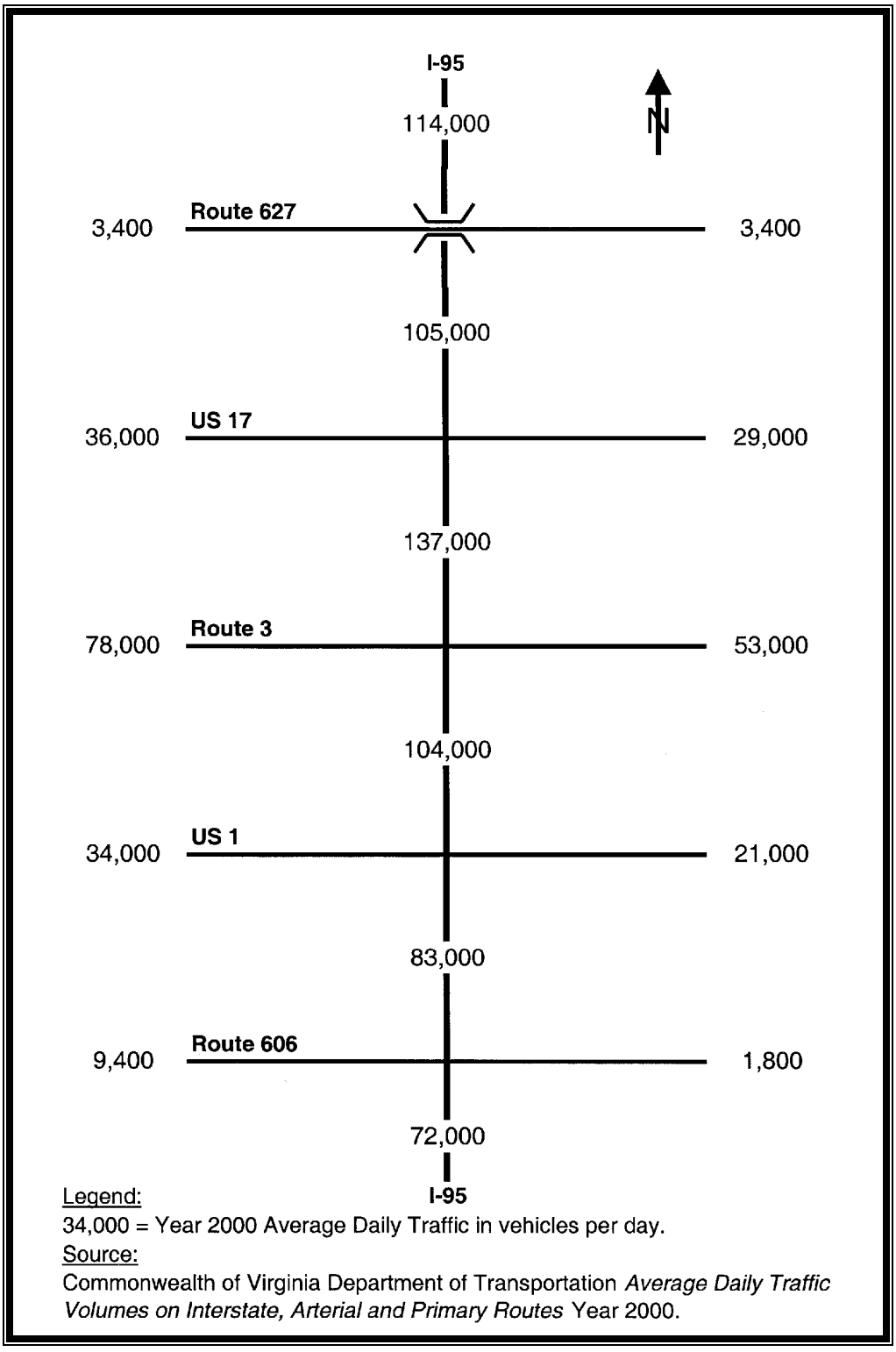


Figure 9A. Current ADT on I-95 and Intersection Cross Routes.

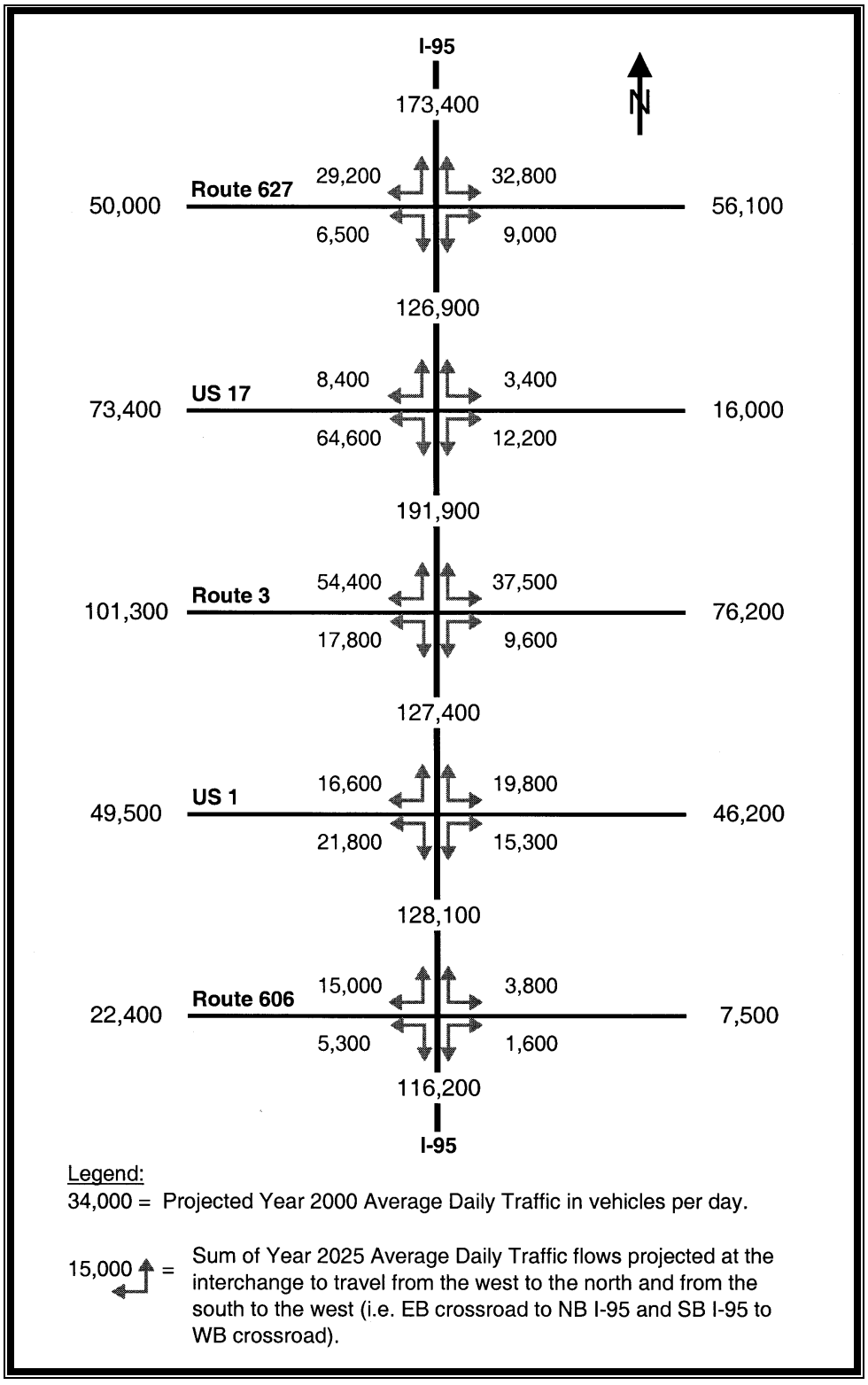


Figure 9B. 2025 Average Daily Traffic Forecasts on I-95 Corridor and Intersecting Cross Routes.

at the Route 3 interchange on the west side of I-95. Construction of the new Fredericksburg access interchange between US 17 and Route 3 would be expected to relieve the Route 3 interchange from much of this new traffic. Much of the growth at the interchange crossroads can be attributed to the household and employment growth that was displayed in Figures 7 and 8.

2025 PM Peak Hour Traffic Flows and Levels of Service for Baseline Scenario

Traffic analyses using Highway Capacity Manual methodologies were conducted to determine the projected year 2025 PM peak hour LOS for I-95 mainline segments, merge and diverge points on I-95, and weaving sections on the C-D roads. The PM peak hour was selected as the critical time period because traffic volumes to and from the ramps and on I-95 are higher than the AM peak period. LOS is a measure used to define the quality of traffic conditions. The scale, similar to letter grades assigned in school, ranges from LOS A, which represents very good flow conditions with little or no delays, to LOS F, which represents congested conditions, long delays, low travel speeds, stop-and-go conditions, and traffic queues. Figure 10 presents a summary of the projected year 2025 PM peak hour volumes and LOS for the Baseline Scenarios.

The traffic analysis of the baseline scenario indicates that capacity problems are projected for the mainline of the freeway and ramps at selected interchanges. The high entering and exiting volumes increase the difficulty of providing acceptable peak hour level of service throughout the corridor. For freeway mainline segments, poor levels of service typically suggest the need for additional travel lanes. For high volume ramps, the challenge to effectively address projected capacity deficiencies is even greater. The design must allow ramp traffic to flow smoothly into an established traffic stream, however ramp geometry is frequently constrained and not easily modified. The analysis conducted for this study found only a few mainline segments and several ramp merge and ramp diverge locations that are projected to operate at LOS E or F in the year 2025 PM peak hour. Moreover, it was determined that the projected PM peak hour traffic volumes for several ramps would exceed the capacity of those ramps. It is important to recognize that, consistent with the scope of this study, level-of-service analyses were not conducted for the terminals of ramps and adjacent intersections on the intersecting crossroads. In all likelihood, the projected increases in ramp volumes will require extensive design modifications that could have an adverse impact on the crossroads traffic and adjacent land use.

A close inspection reveals that during the PM peak hour, LOS F conditions exist on southbound I-95 mainline lanes between U.S. Route 17 and Route 3. It is important to understand that despite the widening of I-95 to four lanes in each direction in this section, traffic conditions would still be congested. In addition, two other freeway mainline sections are projected to operate at LOS E (i.e., “at capacity”) conditions:

- The three lane section of southbound I-95 from the off-ramp to westbound Route 3 to the on-ramp from westbound Route 3 (a fourth lane is added south of this point to create a weaving section); and
- The three lane section of southbound I-95 from the on-ramp from U.S. Route 1 to the off-ramp at Route 606.

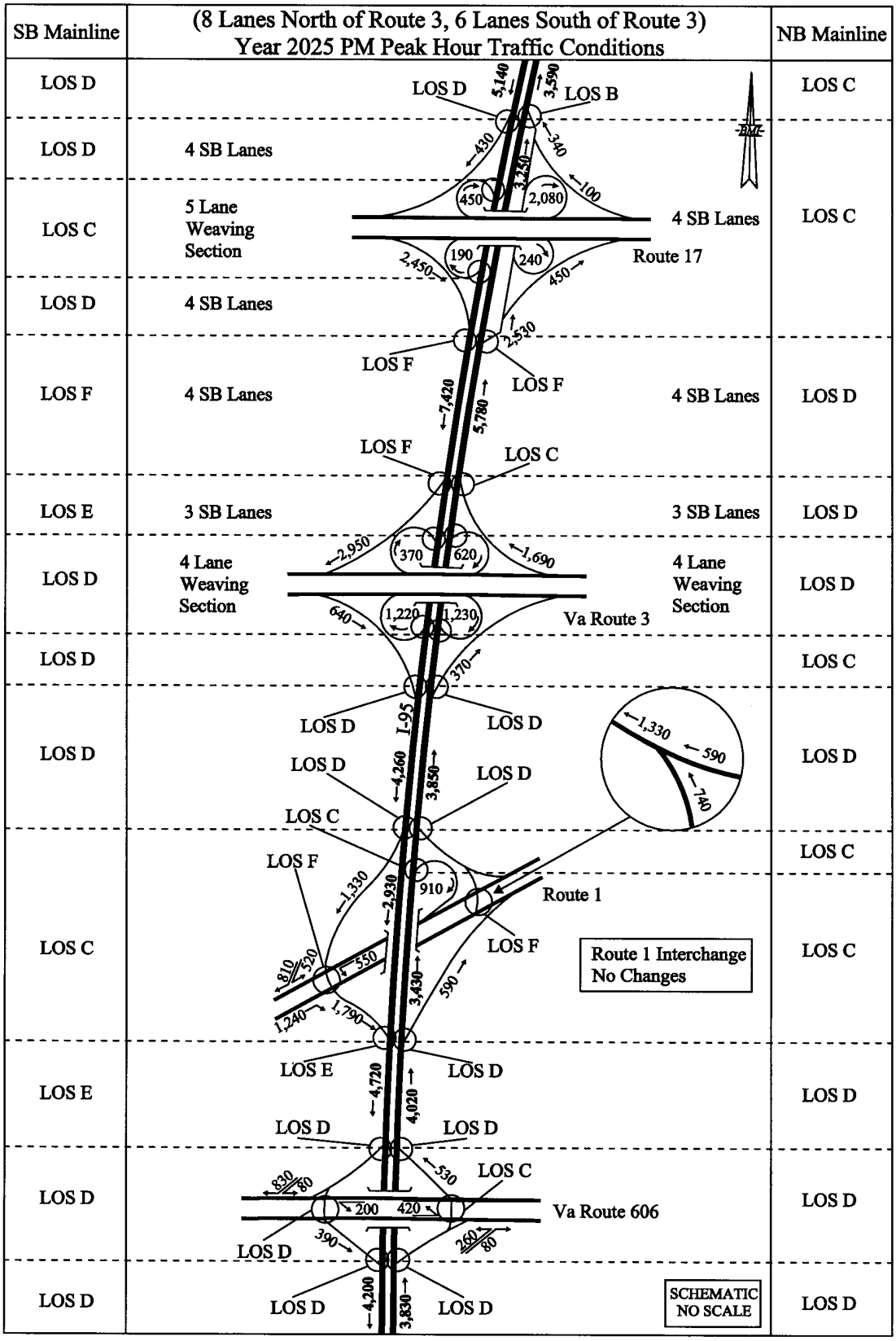


Figure 10. Baseline Year 2025

In addition, there are several merge and diverge locations that are projected to operate at LOS E or F during the PM peak hour in the year 2025. These include the following:

- The merge of the ramp from southbound U.S. Route 17 onto southbound I-95 (LOS F);
- The diverge on southbound I-95 at the ramp to westbound Route 3 (LOS F);
- The merge of the ramp from U.S. Route 1 onto southbound I-95 (LOS E); and
- The diverge on northbound I-95 to U.S. Route 17.

Additionally, the projected PM peak hour volumes exceed the capacity of the following one-lane ramps:

- On-ramp from southbound U.S. Route 17 to southbound I-95;
- Off-ramp from southbound I-95 to westbound Route 3;
- On-ramp from U.S. Route 1 to southbound I-95; and
- Off-ramp from northbound I-95 C-D road to northbound U.S. Route 17.

In addition to the freeway segments, merges, diverges and ramps, LOS F conditions are projected at both signalized intersections of U.S. Route 1 interchange.

Although there were few locations in the northbound direction that are projected to experience LOS F conditions in the PM peak hour, this does not mean that there will be no congestion in the northbound direction. While complete sets of 2025 AM peak hour volumes were not developed, it is projected that significant traffic congestion will occur at the following locations in the AM peak hours:

- Northbound I-95 between Route 3 and U.S. Route 17;
- Off-ramp from northbound I-95 to northbound U.S. Route 17;
- On-ramp from southbound U.S. Route 17 to southbound I-95;
- On-ramp from eastbound Route 3 to northbound I-95;
- Off-ramp from northbound I-95 to southbound U.S. Route 1;
- East intersection of the diamond interchange at Route 606;
- Both signalized intersections at the U.S. Route 1 diamond interchange;
- Diverge on northbound I-95 to westbound Route 3; and
- Diverge on northbound I-95 to U.S. Route 17.

Clearly, there will be many locations in the study area that will experience traffic congestion in the year 2025.

THIS PAGE INTENTIONALLY LEFT BLANK

III. ANALYSIS OF POTENTIAL IMPROVEMENTS TO EXISTING INTERCHANGES

Introduction

As development increases and congestion on I-95 grows in the greater Fredericksburg area, the need for transportation improvements becomes paramount. Traffic volumes on I-95 have grown at a high rate over the last 10 years. Greater levels of development forecasted for the area are projected to result in higher daily and peak period traffic volumes on not only I-95 but also on roads providing access to I-95. Locations where vehicles merge onto and diverge from the I-95 mainline can become choke points in the regional highway network if traffic volumes exceed capacity at those locations. Two means to combat this problem is (1) increase capacity at existing and/or (2) to provide additional access to I-95 at locations that will effectively reduce traffic demand at the existing interchanges. Typically, the construction of all new interchanges is a much more involved and costly process that requires approval of numerous agencies. Frequently, there are limitations with regards to available financial resources and funding levels. Hence, it is also desirable to investigate improvements to existing interchanges as a possible means to combat growing congestion at the existing interchanges. While this does not address the issue of providing improved access to newly developing areas within the greater Fredericksburg area, capacity improvements to existing interchanges can reduce the level of anticipated peak period congestion and facilitate travel and mobility within the region. Often, improvements to existing interchanges can be less expensive than construction of all-new interchanges.

As noted earlier, there are four existing interchanges within the study area limits: U.S. Route 1, U.S. Route 17, Route 3, and Route 606. This section of the report discusses potential improvements that could be implemented to facilitate traffic flow on I-95 through the existing interchanges and enhance safety. After a brief discussion of each interchange, two exhibits are provided for each interchange at the end of the section. The first exhibit is a table that a) describes the rationale on the need for the improvement, discussing what would make the interchange operate more efficiently; b) describes each concept; c) provides an engineering assessment, including the construction cost index and additional right-of-way acreage needed; d) provides an inventory of existing environmental features, listing the amount of wetlands and floodplains that would be affected; e) describes the traffic assessment; f) gives an overall critical assessment; and g) describes whether the alternative was recommended to be advanced or dropped. Following the scenario tables, schematic drawings of each scenario illustrate the proposed improvements. Finally, actual drawings of the proposed improvements are found in Appendix C.

U.S. Route 17 and Route 3

During the analysis, it became clear that isolated improvements implemented at the Route 3 or U.S. Route 17 roads would be insufficient to adequately address the long-term projected capacity deficiencies. Clearly, the single-lane on-ramp from southbound U.S. Route 17 to southbound I-95 and the off-ramp from southbound I-95 to westbound Route 3 can't accommodate the projected 2025 demands at acceptable LOS. In addition, the capacities of the on-ramp from

eastbound Route 3 to northbound I-95 and the off-ramp from northbound I-95 to northbound U.S. Route 17 are expected to be deficient for the projected future traffic volumes. Direct-connect, two-lane ramps will be needed for these movements. C-D roads are needed on I-95 between Route 3 and U.S. Route 17. Even under today's volumes, C-D roads would improve traffic flow through this segment of I-95. The 2025 traffic projections indicate a large number of vehicles access I-95 at U.S. Route 17 and exit at Route 3, and vice versa. These following proposed concepts were developed to address the traffic conditions, and are illustrated in the following pages with the scenario table and schematic drawings at the end of the section, as described above. There are three proposed options for U.S. Route 17 and Route 3. Impacts on wetlands, floodplains, historic sites, and other environmental features would need to be addressed in subsequent environmental documents.

In providing C-D roads on I-95, there are several important issues to consider. The first is the existing Virginia Welcome Center/rest area, which is located west of I-95 and north of Route 3. The Welcome Center is only accessible to southbound I-95 traffic. If the decision is made to maintain the Welcome Center, then the design of the southbound C-D road will be constrained. The constraint will influence the location of the merges and diverges on the mainline. If the Welcome Center is removed, then greater flexibility will be afforded for the design of the southbound C-D road. Specifically, the location of the diverge from the mainline and the merge onto the mainline can be optimally located for safety and traffic efficiency. The weaving length on the southbound C-D road can be maximized and the drivers will be confronted with fewer decisions. In addition, the signing can be simplified because signing to the Welcome Center would no longer be necessary.

A second issue is that the two separated C-D roads will need to cross the Rappahannock River. Clearly, this presents a design challenge. One potential means is through the provision of additional parallel spans. Concerns that have been expressed about impacts to the Rappahannock River itself, and the effects of the bridges on the environment will need to be analyzed in detail and adequately addressed in subsequent studies if this concept is to move forward.

Another issue of concern is the effect that the proposed concept would have on existing development adjacent to the interchange area. It is important to recognize that only conceptual drawings have been developed for this study. Furthermore, the ultimate configuration (and, therefore, impacts on adjacent land) of any interchange modification is subject to the subsequent environmental analysis and design process. Notwithstanding, additional right-of-way is likely to be required in all four of the quadrants at both interchanges and between the interchanges to accommodate the C-D road. Access to existing development near both the I-95/U.S. Route 17 interchange and the I-95/Route 3 interchange may be adversely impacted and, in some cases, may need to be closed to accommodate the proposed changes. It is possible that modifications to the interchanges may require the purchase of all or a portion of parcels that are immediately adjacent to the existing interchanges. Building structures and surface parking areas in those affected areas may need to be razed to provide the additional right-of-way required, thereby forcing the relocation of businesses that currently occupy those premises.

In addition to the impacts on existing development, there will also be an impact to the cross-sections on both Route 3 and U.S. Route 17 and the intersections and access points on Route 3

and U.S. Route 17 that are in close proximity to I-95. For example, the provision of a two-lane on-ramp from southbound U.S. Route 17 to southbound I-95 will necessitate widening of southbound U.S. Route 17 in addition to widening the existing one-lane ramp. Moreover, the intersections on U.S. Route 17 immediately adjacent to the I-95 interchange may require geometric modifications and/or changes to traffic control devices.

For improvement option 1 to the existing interchanges at Route 3 and U.S. Route 17, there were two locations on the C-D roads that were projected to operate at LOS F during the year 2025 PM peak hour. The first location was the weaving section on the northbound C-D road between the ramp from northbound I-95 mainline and the ramp to southbound U.S. Route 17 Business. The second location was the weaving section on the southbound C-D road between the ramp from southbound I-95 and the ramp to westbound Route 3. Both are four-lane weaving areas that are relatively short.

There are a limited number of mitigating measures that can address these capacity deficiencies. Often, the first suggestion is to lengthen the weaving section. However, research has found that the capacity of a weaving section is somewhat insensitive to length. Recent NCHRP research has found that many vehicles attempt to complete their weaving maneuvers within the first 200 feet. Thus, the maximum number of vehicles that can weave is limited. It should be noted that improvement options 2 and 3, which are discussed later, were suggested as a means to reduce weaving on the C-D roads by providing braided ramps. It is projected that braided ramps would effectively mitigate the poor weaving LOS.

In addition to the two locations on the C-D roads, there were several locations where the calculated PM peak hour LOS was D. FHWA has an official policy in which LOS C is the minimum peak hour LOS for interstate freeways. Consequently, FHWA would be looking for LOS C or better conditions to be achieved at all basic freeway sections, merges, diverges and weaving areas on I-95. For the year 2025, PM peak hour levels of service are projected to occur at the following locations:

- Southbound mainline section north of U.S. Route 17;
- Southbound mainline section south of Route 3;
- Northbound mainline section south of Route 3;
- Merge point on southbound I-95 at the two-lane ramp from the southbound C-D road;
- Diverge on northbound I-95 at the two-lane off-ramp to the northbound C-D road; and
- Diverge on southbound I-95 at the one-lane off-ramp to the southbound C-D road.

To improve the LOS from D to C on these sections will be a significant challenge. Simply adding more lanes on I-95 may be cost-prohibitive. Potential mitigation measures to improve the year 2025 PM peak hour levels of service include the following:

<u>Traffic Demand Reduction Strategies</u>

- Promotion of alternative modes of travel.

- Extension of the I-95 HOV facility, which currently ends in Prince William County. This may induce more motorists to form carpools or switch modes to bus transit.
- Reductions in fares and/or increases in service of the Virginia Rail Express (VRE).

Strategies Related to Highway Capacity

- Provision of longer acceleration and deceleration lanes, notably at the two-lane merges and diverges.

- Provision of continuous auxiliary lanes on I-95 from south of Route 3 to the U.S. Route 1 interchange.

- Provision of one additional continuous auxiliary lane on southbound I-95 from the Route 627 interchange to the exit to the southbound C-D road.

- Improve vertical alignment on I-95 and the C-D roads to reduce the negative effect of trucks.

It must be noted that these LOS analyses were run assuming rolling terrain and a high percentage of large trucks, which is appropriate for a planning level analysis. It is this combination of terrain and truck percentage that results in a much higher "equivalent" traffic volume than is reflected in simply vehicles per hour. This contributes greatly to the low levels of service projected for the year 2025 PM peak hour. Based on best available data, the percentage of trucks on I-95 during the PM peak hour is currently about 12-15 percent. It is projected that the growth in personal vehicle travel will exceed the growth in truck traffic. Consequently, by the year 2025, it is projected that the percentage of trucks on I-95, in the section of I-95 between Route 3 and Route 17, will be on the order of 10 percent. It should be noted that if and when more detailed designs are developed, then specific grades and lengths of grade can be determined. An alternative highway capacity methodology exists to examine specific grade segments. When this is done, it is conceivable that the LOS may be different and in some cases better than the results presented herein.

For improvement option 2, the provision of braided ramps effectively addresses the LOS F weaving problem on both the northbound and southbound C-D roads that was present for option 1. Thus, for this option, the year 2025 PM peak hour LOS for all locations was determined to be D or better. There were no locations with LOS E or LOS F. However, under option 2 many of the same issues as were discussed for option 1 remain for the locations with a projected LOS D.

Option 3 is very similar to option 2. The only difference is that, for option 3, the northbound C-D road is not continuous through the Route 17 interchange area. This has the net effect of increasing the weaving length on the northbound C-D road, which results in a projected improvement in the PM peak hour LOS from D to C. The short segment of northbound C-D road that is removed under option 3 affords a "second" path to northbound I-95 for those drivers who entered the northbound C-D road from Route 3 but missed the slip ramp to northbound I-95. Since all drivers originating from Route 3 and bound for northbound I-95 were assumed to use this slip ramp, it was deemed that this short segment was a redundant link that could be removed.

Because the effect was a slight improvement in LOS, it was deemed that option 3 was clearly superior to option 2. Of course, in a manner similar to both options 2 and 3, there are other locations that are projected to operate at LOS D during the year 2025 PM peak hour. The mitigation measures identified earlier in this section are also applicable.

It is important to note that while option 3 is superior to option 2 in terms of the projected year 2025 PM peak hour levels of service, there are traffic and safety benefits attributable to C-D roads that continue through an entire interchange, as is proposed for option 2. Continuous C-D roads provide for an alternative path through an interchange area that could be utilized if and when a traffic-blocking incident occurs on the mainline within the interchange area or the mainline undergoes road construction. This is especially beneficial for emergency vehicles. In addition, continuous C-D roads provide a redundant link for unfamiliar drivers who may become lost or disoriented in the interchange.

As noted earlier in this section, isolated modifications and improvement concepts applicable to only one interchange were considered first. None of the concepts were found to be promising in satisfying the projected traffic demands at acceptable levels of service. The traffic projections that traffic congestion problems are likely to occur due first and foremost to the shear volume of vehicles getting on and off at the two interchanges. The projected demand on several of the existing one-lane ramps will exceed the available capacity. The traffic projections also indicate that there will be a substantial amount of trips traveling between the two interchanges. It is emphasized that the year 2025 land use forecasts, which assume the Celebrate Virginia! Development, were used in the development of the traffic projections. Approximately 1,630 vehicles per hour were projected to enter southbound I-95 from U.S. Route 17 and exit at Route 3 during the year 2025 PM peak hour. There were another 1,280 vehicles per day projected to enter northbound I-95 at Route 3 and then exit onto U.S. Route 17 during the year 2025 PM peak hour.

On the basis of this analysis, option 3 is projected to result in the best PM levels of service compared to options 1 and 2. Moreover, there are very minor differences in the construction cost indices among the three alternatives. Thus, option 3 represents the most promising option of the three developed and studied for the section of I-95 between Route 3 and U.S. Route 17, including the two interchanges. However, it must be understood that this is based primarily on LOS and traffic considerations, without the benefit of detailed environmental assessments or accurate cost estimates that included right-of-way and other costs.

U.S. Route 1

Without improvements or new interchanges for the Spotsylvania Parkway and/or Route 208, the existing geometric configuration of the U.S. Route 1 interchange will not accommodate the projected 2025 traffic at acceptable levels of service. Provision of dual left turn lanes on the off-ramp from southbound I-95 and for the movement from southbound U.S. Route 1 to southbound I-95 would help but still not result in an acceptable LOS. Reconstructing the entire interchange, providing loop ramps in all quadrants and C-D roads would improve projected traffic conditions. There will be right-of-way impacts on adjacent development. Four concepts were developed and are presented on the succeeding pages in scenario tables and schematic drawings.

A series of options were examined for the I-95/U.S. Route 1 interchange, ranging from simple ramp widening to the reconstruction of the entire interchange with loops in all four quadrants and C-D roads on I-95 through the interchange area. As noted earlier in this report, failing levels of service are projected for the two signal-controlled intersections at the diamond interchange. For improvement option 1, which included the provision of a second left turn lane from southbound U.S. Route 1 to southbound I-95, and a second left turn lane on the off-ramp from southbound I-95, the projected year 2025 PM peak hour LOS for this signal-controlled intersection was still F. It is important to note that U.S. Route 1 was assumed to have only two through lanes on each approach to this signalized intersection. Provision of one additional through travel lane in each direction on U.S. Route 1 through this intersection would improve the projected PM peak hour.

Another location that was projected to operate at a low LOS (E) during the PM peak hour in the year 2025 was the southbound section of I-95 south of Route 1. It is important to note that this LOS E condition is common across all options proposed to improve the existing I-95/U.S. Route 1 interchange. This basic freeway section is assumed to have three travel lanes in the southbound direction. While the projected 2025 PM peak hour volume (4,720 vehicles/hour) does not seem to be large enough to warrant LOS E, it is again the combination of the high truck percentage (10%), rolling terrain, and peak hour factor (0.90%) that adversely affects flow. After adjusting for heavy trucks, the "effective" volume in passenger car equivalents is 6,294 passenger cars per hour (pcph). Since the threshold for LOS D on a six lane freeway is 5,952, then the "equivalent" projected volume in passenger car equivalents corresponds to LOS E. Provision of a fourth southbound travel lane on I-95 would certainly improve the projected PM peak hour LOS. Alternatively, improvements in the LOS could also be achieved if the total projected volume or the percentage of trucks were reduced.

It should be noted that there are several other locations that are projected to operate at LOS D during the PM peak hour in the year 2025. These include the basic freeway sections on I-95 north of the U.S. Route 1 interchange (both northbound and southbound), the southbound I-95 section south of U.S. Route 1, the merge locations associated with the on-ramps, and the diverge locations associated with the off-ramps (except for the diverge at the ramp to southbound U.S. Route 1). The traffic demand management strategies discussed in an early part of this chapter for U.S. Route 17 and Route 3 are equally applicable.

Improvement option 2, which involves the removal of the southbound U.S. Route 1 left turn from the western signalized intersection, is projected to effectively address the LOS F deficiency of option 1. Because of the significant increase in volume related to the northbound I-95 to southbound U.S. Route 1 movement, there are concerns about the adequacy of the very tight loop ramp. Consequently, a larger loop ramp is proposed. This will necessitate the relocation of the existing ramp from U.S. Route 1 to northbound I-95. The construction of these new ramps would have an adverse impact on existing development in that quadrant. As with option 1, there are several locations that are projected to operate at LOS D during the year 2025 PM peak hour. Similar to option 1, measures to improve the LOS to C are very limited.

Although all locations except the southbound I-95 section south of U.S. Route 1 were determined to operate at LOS D or better, there was concern about the two exits on northbound I-95 and the dual entrances on I-95 that would continue to exist under option 2. As stated in *A Policy on*

Geometric Design of Highways and Streets (AASHTO, 2001), interchanges that are designed with single exits are superior to those with two exits, especially if one of the exits is a loop ramp. The document points out that whether used in conjunction with a full cloverleaf or with a partial cloverleaf, the single-exit design may improve the operational efficiency of the entire facility. The document indicates that the primary purposes for developing single exits are:

- To remove weaving from the main facility and transfer it to a slower speed facility;
- To provide a high-speed exit from the main roadway for all exiting traffic;
- To satisfy driver expectancy by placing the exit in advance of the separation structure;
- To provide uniformity of exit patterns; and
- To provide decision sight distance for all traffic exiting from the main roadway.

Consequently, options 3A and 3B, which feature C-D roads in both directions on I-95, were proposed. For option 3A, the signal-controlled intersection west of I-95 would be maintained in an attempt to minimize the impacts on adjacent development. However, the year 2025 projected PM peak hour LOS at this intersection was calculated to be E. A limited amount of improvement could be gained through optimized coordination of the signalized intersections along U.S. Route 1. Widening U.S. Route 1 to six lanes in this section could also be effective in improving the LOS. Another means to address the LOS E deficiency would be to remove the signalized intersection altogether. Option 3B provides for a loop to serve the southbound I-95 to northbound U.S. Route 1 movement, thereby removing the need for the signal-controlled intersection. Option 3B is projected to result in a reduction in stopped delay time and improvements in peak hour levels of service, but has a much larger adverse impact on existing development in the immediate interchange area. For both options 3A and 3B, a number of locations are projected to operate at LOS D. Achieving reductions in the projected volumes and/or projected truck traffic would improve the LOS at these LOS D locations. Measures to do so were discussed in the section of this chapter on improvements to the existing interchanges at U.S. Route 17 and Route 3.

On the basis of this analysis, improvements will be needed at the I-95/U.S. Route 1 interchange by the year 2025 due to the projected growth in traffic volumes. Without any additional new interchanges on I-95 south of the Rappahannock River, a substantial growth in traffic is projected for the northbound I-95 to southbound U.S. Route 1 movement. Improvements were deemed to be necessary and appropriate for that ramp, due to the combination of high volumes on a tight ramp with a very sharp radius. Consequently, all options assumed that a new ramp with a larger radius would be constructed. Option 1, which also assumed additional left turn lanes on all applicable approaches at the two signal-controlled intersections, was found to be inadequate because LOS F conditions would continue to exist at the signalized intersection on the west side of I-95. It is recognized that there were only two thru lanes in each direction on U.S. Route 1 at the western signalized intersection. Option 2, which assumed the construction of a new loop ramp to serve the southbound U.S. Route 1 to southbound I-95 movement without C-D roads on I-95, would not only remove left turns from the southbound U.S. Route 1 approach, but would improve the projected PM peak hour LOS to E. In addition, there was a concern that the interchange configuration would be judged to be unacceptable to FHWA because it maintains two exits from northbound I-95, which are generally inferior to single-exit interchanges. Option 3A proposed C-D roads in each direction in addition to the new loop ramps in the southwest and

northwest quadrants. The signal-controlled intersection would continue to exist and is projected to operate at LOS E during the PM peak hour in the year 2025. To address this LOS problem, option 3B was proposed, which featured loop ramps in all four quadrants and no signalized intersections. Based purely on LOS, option 3B is the most promising. However, it has the largest impact area and would have the greatest adverse impacts on the existing development in the existing interchange area. Compared to option 3B, option 3A would have slightly lower LOS but a far less adverse impact on the developed area that includes the retail/outlet mall northeast of I-95. Yet, if FHWA allows two exits to continue to exist on northbound I-95 and does not mandate the construction of a single-exit interchange, then it may be possible to construct option 2. This option has less of an adverse impact on the existing development northeast of I-95, albeit with longer delays and lower LOS due to the signal-controlled intersection northeast of I-95.

At this point in time, a recommendation on the most promising improved interchange concept cannot be presented. There are trade-offs that must be made between: (1) improvements in levels of service for traffic purposes; and (2) adverse impacts on existing development attributable to the additional right-of-way required for the expanded interchange area. It must be understood that this is based primarily on LOS, land take, and traffic considerations, without the benefit of detailed environmental assessments or accurate cost estimates that included right-of-way and other costs.

Route 606

Route 606 west of I-95 is projected to experience a substantial increase in traffic due to increased development to the west. The FAMPO CLRP indicates that Route 606 will be widened to four lanes. Necessary interchange improvements, such as the provision of a new loop ramp in the southeast quadrant to serve the eastbound Route 606 to northbound I-95 interchange and provision of signal control at the two intersections of the off-ramps, will be needed by the year 2025. The concept is illustrated and described in the following scenario table and schematic drawing.

A diamond interchange at the junction of I-95 and Route 606 is projected to operate at reasonably good levels of service (i.e., LOS D or better) for the 2025 PM peak hour under the baseline condition. For the baseline condition, it was assumed that Route 606 would be widened to four lanes through the interchange area and that traffic signal control would be installed at one or both intersections. However, the movement from eastbound Route 606 to northbound I-95 is projected to increase to over 900 vehicles per hour during the 2025 AM peak hour. Delays will be long and congestion is projected if this large of a volume is forced to turn left at a signal-controlled intersection. A more efficient method to accommodate such a large movement at an interchange would be through the provision of a loop ramp for that movement. This is proposed under option 1. By removing the left turn movement from the eastern signal-controlled intersection, the signals can be controlled using a much simpler two-phase operation, thereby minimizing stopped delays for westbound Route 606 traffic and northbound traffic on the ramp from I-95. Thus, traffic flow conditions are projected to improve if option 1 is implemented, especially during the AM peak hour.

On the basis of this analysis, the current traffic volumes do not justify changes to the existing interchange. Clearly, as traffic volumes continue to increase in the future, there will be a need to consider the provision of traffic signal control at the two intersections on Route 606 formed by the ramps of the I-95 diamond interchange. Because a large amount of development is forecasted for the area west of the interchange, it is projected that volumes on Route 606 west of the interchange will be much larger than volumes on Route 606 east of the interchange. Moreover, there are more projected left turns at the eastern intersection of the diamond interchange than at the western interchange. Consequently, the need for traffic signal control at the eastern intersection will manifest itself sooner than the need at the western intersection.

It is likely that interchange improvements will not be needed until after Route 606 volumes increase by a substantial amount and Route 606 is widened to a four-lane highway in conformance with the CLRP. At some point in the future, there will come a time when interchange improvements will be warranted. The projections indicate that the movement from eastbound Route 606 to northbound I-95 in the AM peak hour and the "mirror" movement from southbound I-95 to westbound Route 606 in the PM peak hour will be the highest turn movements at the interchange, by an appreciable amount. Consequently, it will be necessary to consider providing a direct loop to serve the eastbound to northbound movement at the interchange. There will come a time when a simple left turn at the eastern intersection will not be adequate to accommodate the increasing demand.

Summary of Improvements to Existing Interchanges

To summarize, there are four interchanges that currently provide access to I-95 in the greater Fredericksburg area. These interchanges are located at U.S. Route 17, Route 3, U.S. Route 1, and Route 606 at Thornburg. In terms of today's traffic, the interchanges at U.S. Route 17 and Route 3 experience higher traffic flows compared to U.S. Route 1 and Route 606. In terms of existing peak hour levels of service, the diverge on I-95 to westbound Route 3 is currently operating at a very low LOS (F) during the PM peak hour. The merge of the ramp from U.S. Route 1 to southbound I-95 was determined to be operating at or near capacity (LOS E) during the AM peak hour. Most other locations were found to be operating at LOS D or better.

The traffic projections indicate that, without improvement, the peak period traffic demand will exceed the current capacity of one or more ramps at the interchanges at Route 3 and U.S. Route 17 by the year 2025. In addition, without additional improvements at the U.S. Route 1 interchange, the signalized intersection of U.S. Route 1 and the off-ramp from southbound I-95/on-ramp to southbound I-95 is projected to operate at LOS F.

Clearly, the opportunity for increasing the capacity at these interchanges is limited. There is existing development in the vicinity of these interchanges that will limit the ease at which expanded interchanges can be constructed. The additional land needed for an expanded interchange would need to be obtained at additional cost and disruption to the adjacent existing development. Also, existing traffic must be maintained during construction. There are environmental features, including archaeological sites, in the vicinity of the Route 3 widening area. A modified concept or mitigation of some form will be needed to minimize the impact on these sites if an expanded interchange is to be built.

Considering existing traffic volumes and peak hour levels of service, it is clear that the existing interchanges at U.S. Route 17, Route 3, and U.S. Route 1 have greater need of immediate attention than the interchange at Route 606. The diverge of the ramp from southbound Route 3 to westbound Route 3 was calculated to be operating at a failing LOS during the current PM peak hour. Volumes are much higher at those three interchanges compared to volumes at Route 606. While all interchanges are projected to experience increases in traffic volumes, there is a much more immediate need to address capacity deficiencies at the Route 3 interchange, the U.S. Route 17 interchange and the U.S. Route 1 interchange compared to the Route 606 interchange.

One of the major findings of this traffic study is that a substantial amount of traffic is projected on the ramps at U.S. Route 17 and Route 1. In addition, there appears to be a significant interaction in terms of the traffic movement between Route 3 and U.S. Route 17. The projections indicate that there is a substantial volume of traffic that enters I-95 at U.S. Route 17 and then exits at Route 3, and vice versa. It should be recognized that the projections were developed assuming the completion of an outer connector (i.e., the Northwest Outer Connector).

Given the projected number of vehicles that enter at one interchange and then exit at the other interchange, it is logical and appropriate to consider these interchanges at U.S. Route 17 and Route 3 concurrently. The section of I-95 that lies between the two interchanges was found to carry the highest existing volumes, as well as the highest volumes projected for the year 2025, out of all the segments of I-95 in the study area. Based on these factors, it might be appropriate to assign higher consideration to this segment of I-95 and the two interchanges than to the I-95/U.S. Route 1 interchange. This is not to say that improvements are not needed to address the growing congestion problems projected for the U.S. Route 1 interchange. On the contrary, improvements are needed to address these issues.

Table 3. Assessment Sheet for Existing Interchange Scenario U.S. Route 17 & Route 3-Option 1.

<table>
<tr><td colspan="2">Rationale on the Need for the Improvements to Existing Interchange

Both U.S. Route 17 and Route 3 currently experience congestion. As traffic flows are projected to increase, so will congestion. Volumes on four single-lane ramps are projected to greatly exceed the capacity of those ramps.</td></tr>
<tr><td colspan="2">Description of Concept

• Continuous C-D road for SB I-95 between U.S. Route 17 and Route 3.
• 2-lane fly-over off-ramp from NB I-95 mainline to NB C-D road south of U.S. Route 17.
• 2-lane fly-over off-ramp from SB I-95 mainline to SB C-D road north of Route 3.
• 2-lane semi-direct ramp connection from EB Route 3 to NB C-D road.
• 2-lane on-ramps from (a) NB C-D road to NB I-95 mainline north of U.S. Route 17 and (b) SB C-D road to SB I-95 south of Route 3.
• 4-lane weaving areas on (a) the NB C-D road between fly-over ramp from NB I-95 and the exit to SB U.S. Route 17 Business and (b) the SB C-D road between the fly-over ramp from SB I-95 and the exit to WB Route 3.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• Introduction of continuous C-D roads, fly-over ramps, larger radii and/or directional ramps at the interchanges improves traffic operation and safety.
• Stage construction is required to maintain traffic.
• New parallel bridges over Rappahanock River require permit.
• Required are the relocation or major modification of the Welcome Center and reconstruction of Fall Hill Avenue overpass.
• Additional right-of-way required.</td><td>Construction Cost Index= 107</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way= 41</td></tr>
<tr><td rowspan="2">Environmental Features Present

• One existing architecturally historic property in the vicinity of Route 3 interchange.
• Existing housing and occupied properties near Route 3 / I-95 junction.</td><td>Affected Wetland Acreage= 1.3</td></tr>
<tr><td>Affected Floodplain Acreage= 2.3</td></tr>
<tr><td>Traffic Assessment
• 4-lane weaving areas on both the NB and SB C-D roads are projected to operate at LOS F during the PM peak hour.
• LOS D or better for other locations analyzed.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement
• Congested PM peak hour traffic flow projected on the both the NB and SB C-D lanes.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop (See Page 26)
See Option 2</td></tr>
</table>

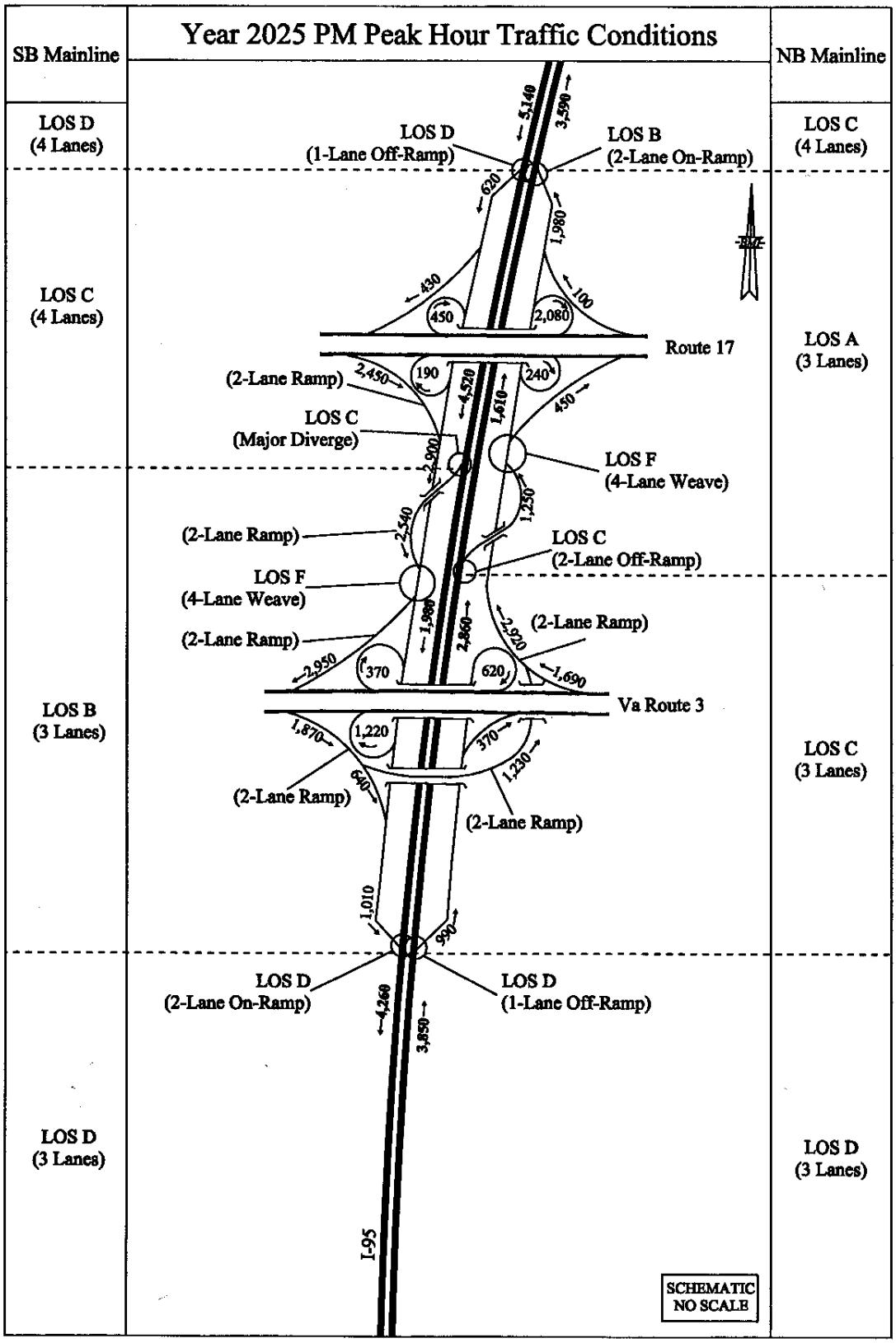


Figure 11. Route 17 & 3: Option 1

Table 4. Assessment Sheet for Existing Interchange Scenario
U.S. Route 17 & Route 3-Option 2

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange

Both U.S. Route 17 and Route 3 currently experience congestion. As traffic flows are projected to increase, so will congestion. Volumes on four single-lane ramps are projected to greatly exceed the capacity of those ramps.</td></tr>
<tr><td colspan="2">Description of Concept

Same features as option 1 with the following exceptions:
• Braided slip ramps for both NB and SB I-95. One ramp goes from SB I-95 mainline to SB C-D road, while another ramp is grade separated to go from the SB C-D road to the SB I-95 mainline. For NB direction, there is one ramp that goes from the NB I-95 mainline to the NB C-D road and a second grade-separated ramp that goes from the NB C-D road to the NB I-95 mainline.
• There is also a semi-direct ramp connection from the NB C-D road to NB U.S. Route 17.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• Introduction of continuous C-D roads, braided ramps, larger radii and/or directional ramps at the interchanges improves traffic operation and safety.
• Stage construction is required to maintain traffic.
• New parallel bridges over Rappahanock River require permit.
• Required are the relocation or major modification of the Welcome Center and reconstruction of Fall Hill Ave overpass.
• Additional right-of-way required.</td><td>Construction Cost Index= 110</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way= 45</td></tr>
<tr><td rowspan="2">Environmental Features Present

• One existing architecturally historic property in the vicinity of Route 3 interchange.
• Existing housing and occupied properties near Route 3 / I-95 junction.</td><td>Affected Wetland Acreage= Not estimated because option dropped</td></tr>
<tr><td>Affected Floodplain Acreage= Not estimated because option dropped</td></tr>
<tr><td>Traffic Assessment

• All locations are projected to operate at LOS D or better for the PM peak hour.
• Braided ramps reduce weaving area on C-D roads.</td><td> 
All locations at LOS C or D</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Has promise, although Option 3 provides a superior LOS at one location. Compared to Option 3, the short section of the NB C-D road gives drivers coming from Route 3 a second (redundant) path to go NB on I-95.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop (See Page 27)
See Option 3</td></tr>
</table>

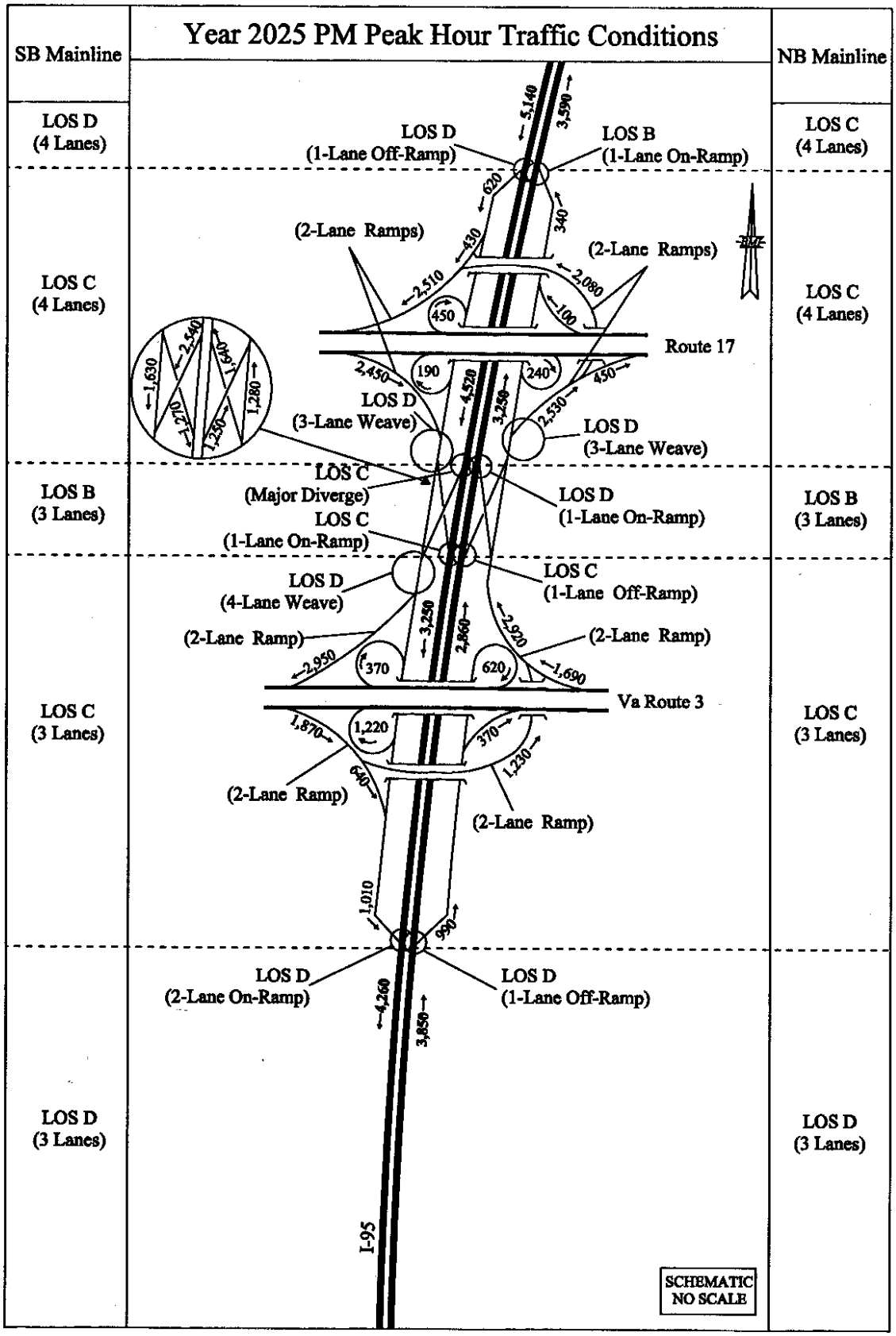


Figure 12. Route 17 & 3: Option 2

Table 5. Assessment Sheet for Existing Interchange Scenario
U.S. Route 17 & Route 3-Option 3

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange

Both U.S. Route 17 and Route 3 currently experience congestion. As traffic flows are projected to increase, so will congestion. Volumes on four lane ramps are projected to greatly exceed the capacity of those single lane ramps.</td></tr>
<tr><td colspan="2">Description of Concept

All the same features of Option 2, except for the following:
• The NB C-D road, which begins at Route 3, does not continue through to I-95 north of U.S. Route 17. The NB C-D road ends at the ramp to NB U.S. Route 17.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• Introduction of continuous C-D roads, braided ramps, larger radii and/or directional ramps at the interchanges improves traffic operation and safety.
• Stage construction is required to maintain traffic.
• New parallel bridges over Rappahanock River require permit.
• Required are the closure or major modification of the Welcome Center and reconstruction of Fall Hill Ave overpass.
• Additional right-of-way required.</td><td>Construction Cost Index=
110</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
45</td></tr>
<tr><td rowspan="2">Environmental Features Present

• One existing architecturally historic property in the vicinity of Route 3 interchange.
• Existing housing and occupied properties near Route 3/I-95 junction.</td><td>Affected Wetland Acreage=
1.3</td></tr>
<tr><td>Affected Floodplain Acreage=
2.3</td></tr>
<tr><td>Traffic Assessment

• The removal of the section of the NB C-D road just south of U.S. Route 17 results in an improvement in LOS of the 3-lane weaving section compared to Option 2 (e.g., LOS D to LOS C).
• All other locations projected to operate at LOS D or better in PM peak hour.</td><td> 
All locations at LOS C or D</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• No LOS F locations identified for PM Peak hour.
• Feasible interchange concept.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

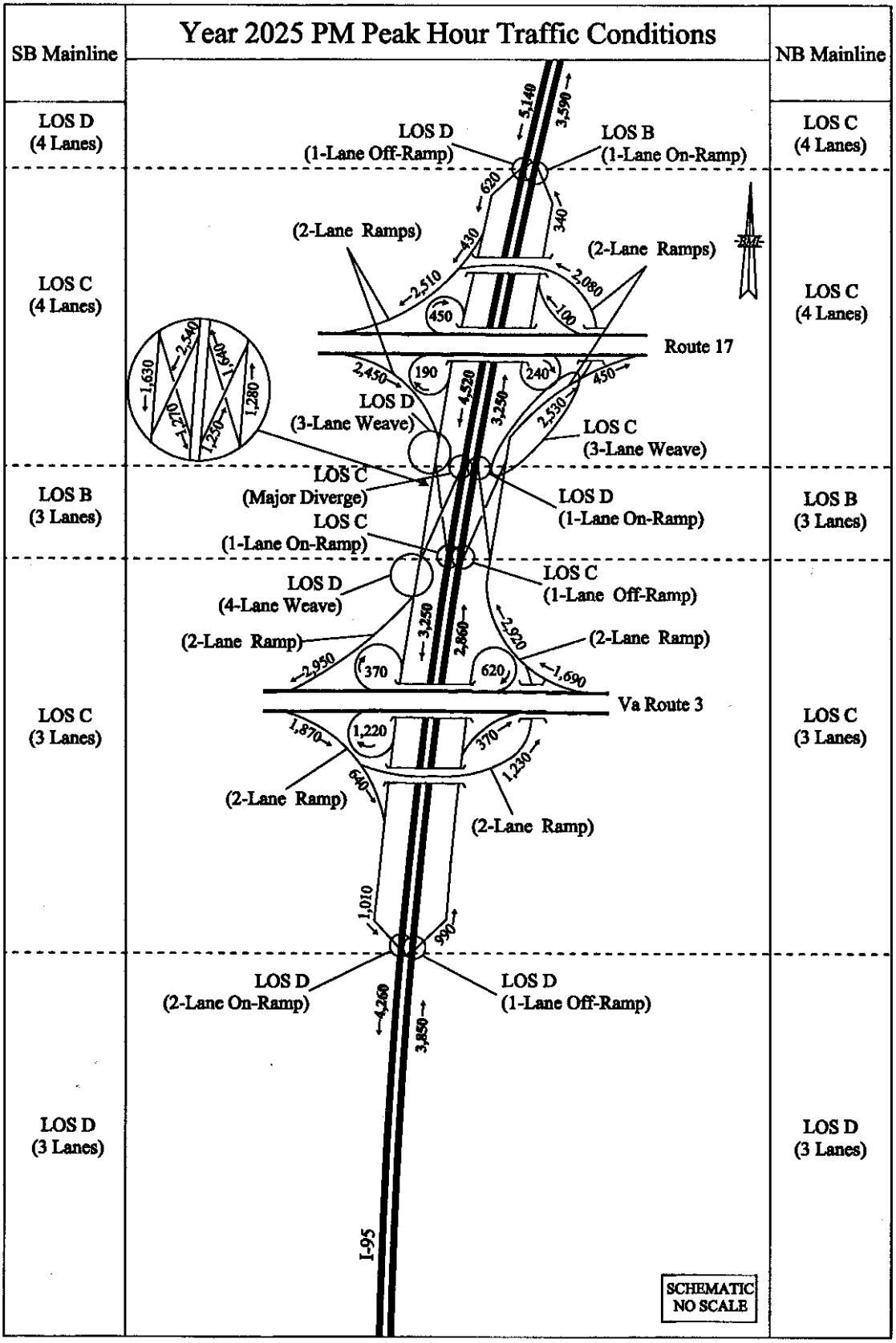


Figure 13. Route 17 & 3: Option 3

Table 6. Assessment Sheet for Existing Interchange Scenario
U.S. Route 1-Option 1

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange
Congestion is projected to worsen at this interchange, especially the signalized intersections of the ramp termini. Assuming no new interchanges on I-95, the geometry of the ramp from NB I-95 to SB U.S. Route 1 is inadequate to accommodate the projected traffic flow at acceptable levels of service.</td></tr>
<tr><td colspan="2">Description of Concept
New longer loop ramp for NB I-95 to SB U.S. Route 1.
Second left turn lane added on NB U.S. Route 1 approach to eastern signalized intersection.
New ramp to NB I-95 to accept two left turn lanes from NB U.S. Route 1; two lanes on ramp tapered to one prior to merge onto NB I-95.
Ramp from SB U.S. Route 1 to SB I-95 widened.
Second left turn lane added on SB I-95 off ramp approach to western signalized intersection.
Second left turn added on SB U.S. Route 1 approach to western signalized intersection.
Ramp to SB I-95 widened to a two-lane on-ramp with an associated widening of the acceleration lanes on SB I-95.</td></tr>
<tr><td rowspan="2">Engineering Assessment
Geometric features meet AASHTO and VDOT standards except the dual left turn lanes on U.S. Route 1 under the bridge.
Introduction of higher speed ramps on a semi-cloverleaf interchange improves the functionality of the U.S. Route 1 interchange.
Two exits on NB I-95 is not the preferable option.
No major construction or signing problems.
No problem maintaining traffic if constructed.
Additional right-of way required.
Two exits on NB and two entrances on SB.</td><td>Construction Cost Index= 8</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way= 10</td></tr>
<tr><td rowspan="2">Environmental Features Present
None identified based on available mapping.</td><td>Affected Wetland Acreage= Not estimated because option dropped</td></tr>
<tr><td>Affected Floodplain Acreage= Not estimated because option dropped</td></tr>
<tr><td>Traffic Assessment
LOS F projected for PM peak hour at western signalized intersection.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement
Without any new interchanges and assuming two thru travel lanes in each direction on U.S. Route 1 at the western signalized intersection, congested PM peak hour traffic conditions are projected for the analysis year of 2025.
Significant impact on existing development in northern quadrant.
Two exits on NB I-95 will continue to exist under this option. Current design standards strongly advocate for single exits for interchanges. Provision of the new loop ramp for the NB I-95 to SB U.S. Route 1 movement will increase the capacity and improve geometry and quality of flow.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop (See Page 28, 29)
See Option 2</td></tr>
</table>

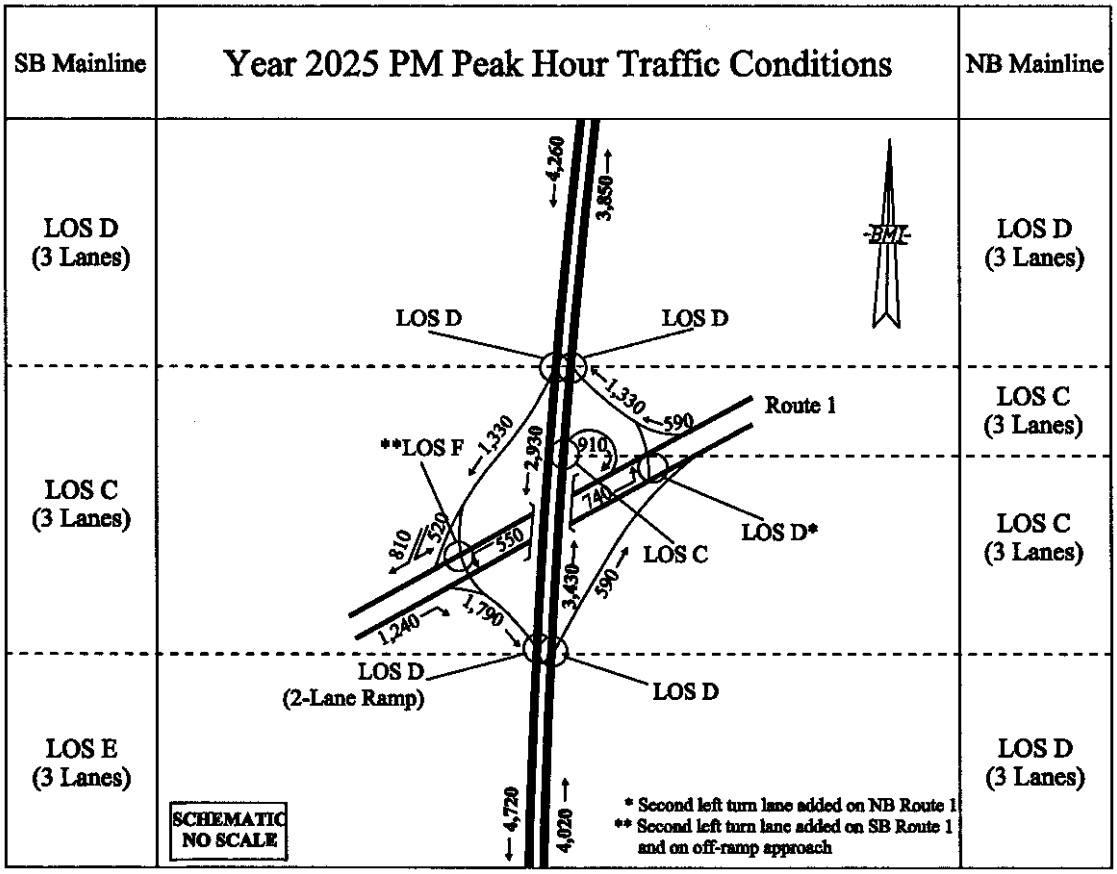


Figure 14. Route 1: Option 1

Table 7. Assessment Sheet for Existing Interchange Scenario
U.S. Route 1-Option 2

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange

Congestion is projected to worsen at this interchange, especially the signalized intersections of the ramp termini. Assuming no new interchanges on I-95, the geometry of the ramp from NB I-95 to SB U.S. Route 1 is inadequate to accommodate the projected traffic flow at acceptable levels of service.</td></tr>
<tr><td colspan="2">Description of Concept

• Second left turn lane added on NB U.S. Route1.
• Second left turn lane added on the SB U.S. Route 1 and the SB I-95 off-ramp approaches.
• NB off-ramp to WB U.S. Route 1.
• SB on-ramp from WB U.S. Route 1.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT requirements.
• Introduction of higher speed ramps on a half-cloverleaf interchange improves the functionality of the U.S. Route 1 interchange.
• No major constructability or signing problems.
• No problem maintaining traffic if constructed.
• Two exits in NB and two entrances in SB I-95 are not the most favored option.
• Additional right-of-way required.</td><td>Construction Cost Index=
8</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
19</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
0.1</td></tr>
<tr><td>Affected Floodplain Acreage=
0.5</td></tr>
<tr><td>Traffic Assessment

• LOS E projected for segment of SB I-95 south of the interchange.
• LOS E projected for signalized intersection of ramp from SB I-95 and U.S. Route 1 (western intersection).
• LOS D or better projected for all other locations.</td><td> 

A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Significant impacts on existing development in the northern and western quadrants. Potential impacts on existing development in the eastern quadrant.
• Provision of new loop ramps for the NB I-95 to SB U.S. Route 1 and the SB U.S. Route 1 to SB I-95 movements will increase capacity, improve geometry and facilitate traffic flows.
• The option does not feature any C-D roads. Two exits would continue to exist on NB I-95 for this interchange. Current design standards strongly advocate single exits at interchanges.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Options 3A & 3B</td></tr>
</table>

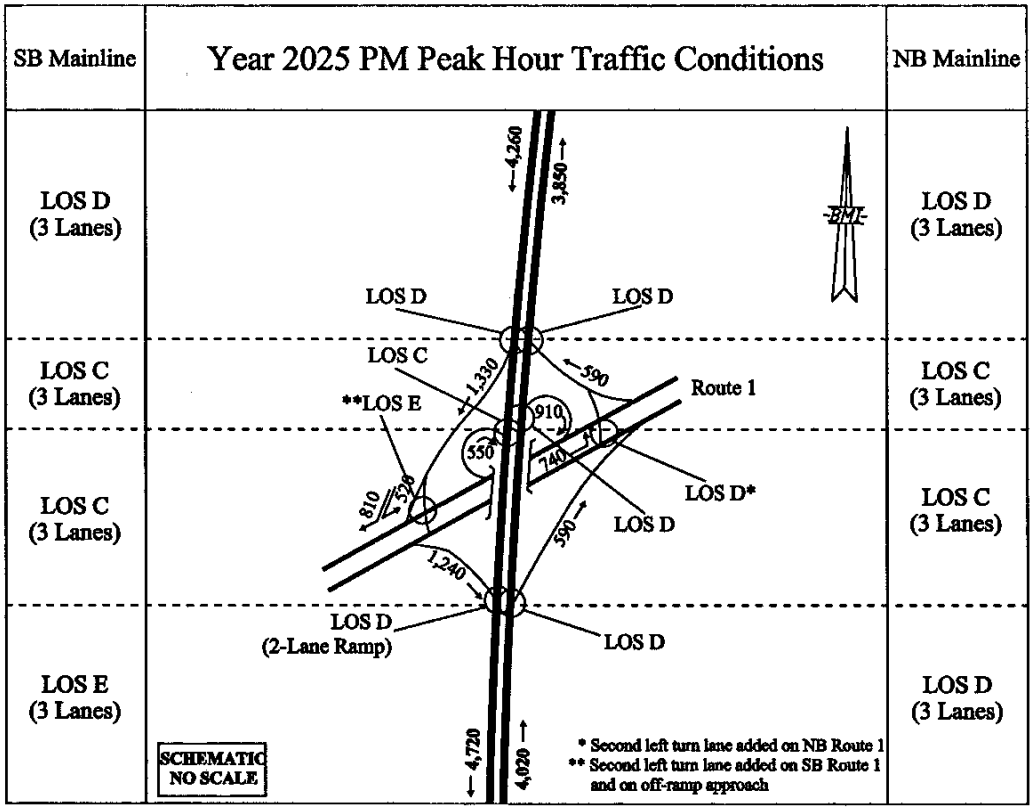


Figure 15. Route 1: Option 2

Table 8. Assessment Sheet for Existing Interchange Scenario
U.S. Route 1-Option 3A

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange

Congestion is projected to worsen at this interchange, especially the signalized intersections of the ramp termini. Assuming no new interchanges on I-95, the geometry of the ramp from NB I-95 to SB U.S. Route 1 is inadequate to accommodate the projected traffic flow at acceptable levels of service.</td></tr>
<tr><td colspan="2">Description of Concept

Same as Option 1, with the following exceptions:
• C-D road before and after U.S. Route 1.
• SB and NB off-ramps to and from C-D road instead of I-95.
• Addition of NB on-ramp to C-D road from EB U.S. Route 1.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• Introduction of C-D roads and higher speed full access ramps on a partial cloverleaf interchange improves the functionality of the U.S. Route 1 interchange.
• Single exit and entrance in each direction improves traffic safety on the mainline.
• No major construction or signing problem.
• No problem maintaining traffic if constructed.
• One weaving segment on NB I-95 C-D road.
• Additional right-of-way required.</td><td>Construction Cost Index=
16</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
37</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping</td><td>Affected Wetland Acreage=
0.5</td></tr>
<tr><td>Affected Floodplain Acreage=
3.1</td></tr>
<tr><td>Traffic Assessment

• LOS E projected for segment of SB I-95 south of the interchange.
• LOS E projected for signalized intersection of ramp from SB I-95 and U.S. Route 1 (western intersection).
• LOS D or better projected for all other locations.</td><td> 

A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Significant impacts on existing development in the northern, western and especially the eastern quadrants.
• Provision of C-D roads and new loops in northern, western and eastern quadrant will increase capacity, improve geometry and facilitate flows.
• C-D roads will improve the quality of flow on I-95 mainlines.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Option 3B</td></tr>
</table>

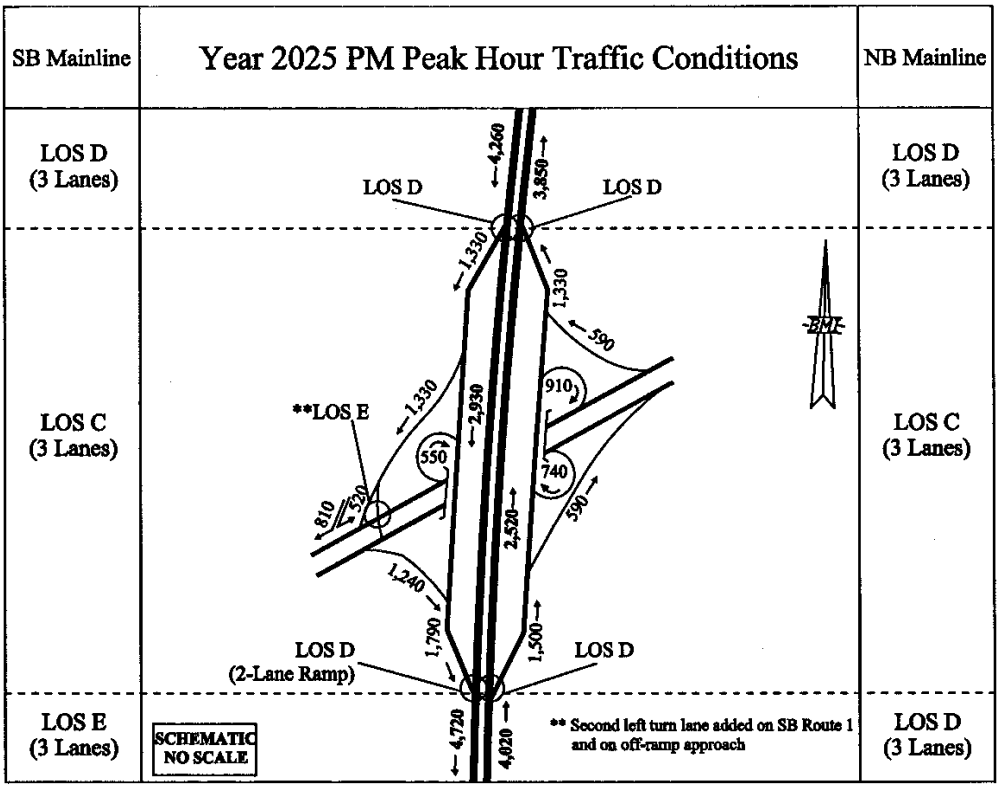


Figure 16. Route 1: Option 3A

Table 9. Assessment Sheet for Existing Interchange Scenario
U.S. Route 1-Option 3B

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange:

Congestion is projected to worsen at this interchange, especially the signalized intersections of the ramp termini. Assuming no new interchanges on I-95, the geometry of the ramp from NB I-95 to SB U.S. Route 1 is inadequate to accommodate the projected traffic flow at acceptable levels of service.</td></tr>
<tr><td colspan="2">Description of Concept

Same as option 3A with the following exception:
• Addition of SB off-ramp to EB U.S. Route 1.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT requirements.
• Introduction of C-D roads and higher speed full access ramps on a full cloverleaf interchange improves the functionality of the U.S. Route 1 interchange.
• Single exit and entrance in each direction improves safety on the mainline.
• No major constructability and signing problems.
• No problem maintaining traffic if constructed.
• Two weaving segments on C-D roads.
• Additional right-of-way required.</td><td>Construction Cost Index=
20</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
53</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
0.1</td></tr>
<tr><td>Affected Floodplain Acreage=
5.8</td></tr>
<tr><td>Traffic Assessment

• LOS D or better with the exception of segment of SB I-95 south of interchange.</td><td> 
A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Significant impacts on existing development in all four quadrants.
• Provision of C-D roads and new loops in northern, western and eastern quadrant will increase capacity, improve geometry and facilitate flows.
• C-D roads will improve the quality of flow on I-95 mainlines.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

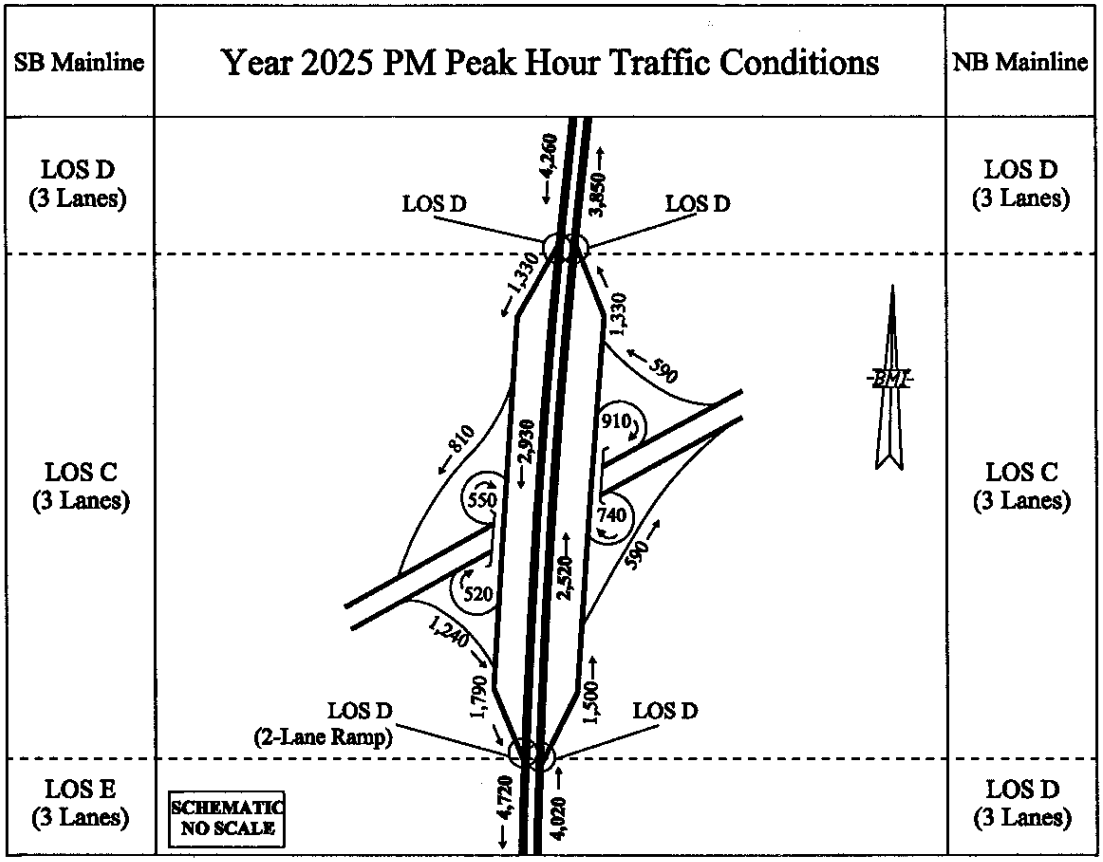


Figure 17. Route 1: Option 3B

Table 10. Assessment Sheet for Existing Interchange Scenario
Route 606

<table>
<tr><td colspan="2">Rationale on the Need for the Improvement to Existing Interchange
While generally acceptable traffic conditions currently exist at this interchange, a substantial increase in traffic to and from the west is projected. Before 2025, signal control will be warranted at the two intersections of the diamond interchange, especially if Route 606 is widened to four lanes in accordance with the FAMPO long-range plan. Traffic increases may necessitate further improvements such as the provision of a loop ramp in the SE quadrant to accommodate the projected heavy AM peak hour volume.</td></tr>
<tr><td colspan="2">Description of Concept
Note: The baseline assumes that Route 606 will be widened to four lanes through the interchange area. This concept adds the following features:
• Provision of new loop ramp in southeast quadrant to serve EB Route 606 to NB I-95.
• Provision of traffic signal control at the two intersections.</td></tr>
<tr><td rowspan="2">Engineering Assessment
• Geometric design meets AASHTO and VDOT requirements.
• Simple to construct and sign.
• No maintenance or traffic problems are foreseen.
• New loop ramp for projected traffic requirements.
• Additional right-of-way required.</td><td>Construction Cost Index=
12</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
25</td></tr>
<tr><td rowspan="2">Environmental Features Present
• State lands</td><td>Affected Wetland Acreage=
0.3</td></tr>
<tr><td>Affected Floodplain Acreage= No impacts</td></tr>
<tr><td>Traffic Assessment
• The projected traffic flows will exceed the existing capacity at the existing intersections on both sides of I-95. However, the baseline condition assumes that Route 606 will be widened to two lanes in each direction. Clearly, traffic signal control will be needed at both intersections. While the LOS analyses revealed LOS D or better for all locations for the year 2025 PM peak hour, a heavy left turn volume (over 800) is likely for the left from EB Route 606 to NB I-95 on-ramp in the 2025 AM peak hour. Although LOS analyses were not performed for the AM peak hour, it is likely that a signalized intersection with one left turn lane will experience traffic congestion during the AM peak hour.
• The 3-lane section of SB I-95 north of Route 606 is projected to operate at LOS D during the PM peak hour due to the volume of traffic and expected high truck percentage.</td><td> 
All locations at LOS C or D</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement
• In the FAMPO long range plan, this section of Route 606 is planned to be widened to 4-lanes. That means the existing two-lane bridge will need to be widened or a new, parallel bridge structure will need to be constructed. The PM movement from SB I-95 to WB Route 606 and the “mirror” AM movement from EB Route 606 to NB I-95 are projected to be over 800 vehicles per hour. In lieu of accommodating over 800 left turns at a signalized intersection, a loop ramp would be preferable.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

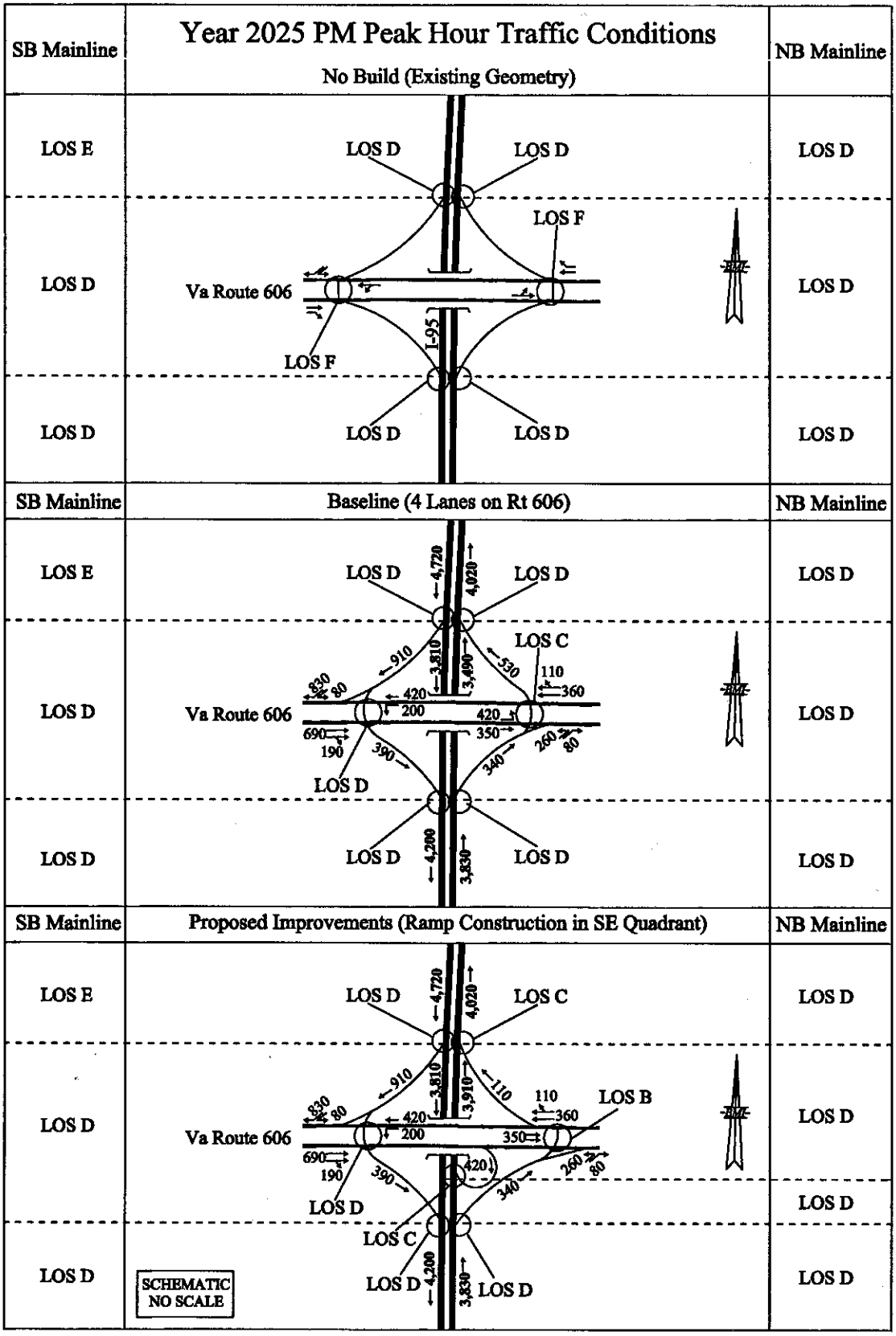


Figure 18. Route 606

IV. ANALYSIS OF POTENTIAL NEW INTERCHANGES

Screening Analysis

Following preliminary analysis, the FAMPO Technical Committee decided to carry forward five candidate interchange locations into a screening analysis:

1. New Fredericksburg access between Route 3 and the Rappahannock River;
2. Route 620;
3. Route 208;
4. Spotsylvania Parkway; and
5. Route 608.

Initial model runs were made to produce 2025 projections of ADT that would be found if these interchanges were added to the network. Estimates of both crossroad volumes and ramp volumes were produced and reviewed with the FAMPO Technical Committee. Based on this initial data, it was found that a new interchange at Route 608 would not be projected to generate levels of traffic that would justify construction of a new interchange. Therefore, a new interchange at Route 608 was dropped from further consideration.

A package of eleven alternative build scenarios, in addition to a baseline scenario without additional interchanges, was developed to evaluate the effects of combinations of new interchanges from a traffic standpoint. In addition, for several of the scenarios, closure of the ramps at the existing U.S. Route 1 interchange was tested in combination with the addition of a new interchange for the Spotsylvania Parkway. Table 11 below summarizes the features of these scenarios.

Table 11. Summary of Features of Scenarios.

Interchange Assumptions					
Scenario	New Fredericksburg Access	Route 620	Route 208	Spotsylvania Parkway	Closure of U.S. Route 1 Ramps
Baseline	No	No	No	No	No
Full Build	Yes	Yes	Yes	Yes	No
A	No	No	No	Yes	No
B	Yes	No	No	No	No
C	No	No	Yes	No	No
D	No	Yes	No	No	No
E	Yes	No	No	Yes	No
F	Yes	No	No	Yes	Yes
G	Yes	No	Yes	Yes	No
H	Yes	No	Yes	Yes	Yes
I	Yes	Yes	No	Yes	No
J	Yes	Yes	No	Yes	Yes

2025 ADT model runs were made for each of the scenarios and the following performance measures were quantified for each:

- Vehicle miles of travel (VMT) on roadway links with a volume to capacity ratio greater than 1 (i.e., over capacity conditions);
- Number of congested crossroad links; and
- Sum of ADT ramp volumes.

This analysis included individual and combinations of two or more new interchanges, including some that assumed the closure of the existing I-95 access at the U.S. Route 1 interchange. Year 2025 ADT traffic projections were developed and traffic-based MOEs were calculated. The results were presented to the FAMPO Technical Committee and the FAMPO Policy Committee, and four scenarios were selected for more detailed analysis.

Based on the results of this screening analysis, and in consultation with the FAMPO Technical Committee, Scenarios E, F, G and H were carried forward for subsequent and more detailed analyses. Table 12 presents a summary of the findings.

Table 12. Scenario Summary Results and Discussion

Scenario	VMT on Links with Volume to Capacity > 1.0	No. of Congested Crossroad Links	Sum of Daily Ramp Volumes (1,000 veh./day)	Discussion
F	55	3	437	1. Severs direct interstate access to U.S. Route 1, which serves significant amount of existing development. 2. Severs interstate connection to a parallel facility, which could have a negative impact on I-95 incident management.
E	56	3	462	None of the negative impacts noted above. Could be implemented with or without continuous C-D roads between U.S. Route 1 and Spotsylvania Parkway.
G	79	5	486	Would require continuous C-D roads between Rt. 208 and U.S. Route 1.
I	82	6	463	1. Compared to G, this scenario serves less anticipated future growth. 2. Interchange design would impact existing park-and-ride lot.
H	86	5	432	Has same negative impacts as F.
B	88	5	411	Does not provide interstate connection to a major circumferential facility that would serve areas planned for new development.
J	95	7	435	Has same negative impacts as F.
Full Build-out	90	6	518	1. Most costly scenario, which may be rendered not feasible by financial constraints. 2. May lead to increased congestion and/or significant increase in access points on I-95 (with or without continuous C-D road). 3. May promote increases in short trips using I-95.
A	110	7	433	Has same negative impacts as D.
D	110	8	406	Does not provide interstate access to a major planned development and does not provide substantial reduction in congestion in the Route 3 corridor.
Baseline	111	6	385	Used for comparison with build alternatives.
C	115	7	413	Has same negative impacts as D.

New Fredericksburg Access

This study did not involve further analysis of the new Fredericksburg access interchange, since an interchange justification study had been previously completed for that location and submitted to the FHWA. The IJS provided a very detailed operational analysis of an interchange design concept at the Fredericksburg location. This analysis, which includes CORSIM traffic modeling of a conceptual design, is considerably more involved than the current C-D Access Study. The IJS, and the conceptual design it contains, has undergone previous technical review and conditional approval by VDOT and FHWA. Because of this, it was decided not to do further analysis on the interchange as a part of the current study. It is noted that prior to the approval of any new interchange on I-95, a similar IJS, with a detailed operations analysis, will have to be developed for each proposed location.

Alternatives Studied in Greater Detail

The projected year 2025 daily and PM peak hour traffic volumes were forecasted for the baseline scenario and the four scenarios. These traffic projections were subsequently used to analyze potential improvements to existing interchanges and different conceptual interchange design configurations for each scenario.

Construction cost indices were developed to facilitate comparison among alternatives. The construction cost index is based on a weighted combination of new pavement area and bridge structure area associated with each alternative. An environmental overview was prepared to indicate previously identified environmental features affecting each scenario.

Analysis of individual interchanges revealed that the greatest benefits in terms of satisfying projected traffic demand resulted from two new interchanges: (1) at the Spotsylvania Parkway south of the existing overpass for U.S. Route 17 Bypass; and (2) a new interchange on I-95 between Route 3 and the Rappahannock River. Consequently, all four of these scenarios assumed the construction of a new Fredericksburg access interchange and the Spotsylvania Parkway interchange. Differences among the scenarios are identified below:

- Scenario E assumed improvements to the U.S. Route 1 interchange;
- Scenario F assumed closure of access at the U.S. Route 1 interchange;
- Scenario G assumed new interchange at Route 208 and improvements to the U.S. Route 1 interchange; and
- Scenario H assumed new interchanges at Route 208 and closure of access at the U.S. Route 1 interchange.

The following scenario tables and schematic drawings illustrate the potential improvements for each scenario. The exhibits are the same as those used for the existing interchanges. Scenario E has five options, scenario F one, scenario G six and scenario H four.

Table 13. Assessment Sheet for New Interchange Scenario E-1

<table>
<tr><td colspan="2">Rationale for Scenario
Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.</td></tr>
<tr><td colspan="2">Description of Concept
• Full cloverleaf interchange with C-D roads at Spotsylvania Pkwy.
• Second left turn lane added to SB and WB approaches at intersection of U.S. Route 1 and SB I-95 ramps.
• Auxiliary 4th lane on SB I-95 mainline between U.S. Route 1 and Spotsylvania Pkwy.</td></tr>
<tr><td rowspan="2">Engineering Assessment
• Geometric design meets AASHTO and VDOT standards except the segment of U.S. Route 1 under I-95 bridge. This segment with dual left turn lanes from U.S. Route 1 to I-95 is sub-standard unless the dual left turn lanes are staggered.
• This concept is constructable and requires additional right-of-way.
• Spacing between U.S. Route 1 ramps and Spotsylvania Parkway interchange is sufficient such that continuous C-D roads are not mandated by standards.</td><td>Construction Cost Index=
34</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
93</td></tr>
<tr><td rowspan="2">Environmental Features Present
• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
No impacts</td></tr>
<tr><td>Affected Floodplain Acreage=
No impacts</td></tr>
<tr><td>Traffic Assessment
• LOS E projected for SB I-95 south of Spotsylvania Parkway.
• LOS C conditions projected in year 2025 PM peak hour for five-lane weaving area on SB I-95 between U.S. Route 1 and Spotsylvania Parkway. A four-lane weaving area is projected to provide LOS E.
• A two-lane ramp to SB I-95 is necessitated by the 1,840 vph projected for ramp to SB I-95.</td><td> 
A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement
• Least expensive of design options for Scenario E.
• Substandard geometry (loop and ramp in NE quadrant) at U.S. Route 1 interchange continues to exist.
• High volume on short, tight loop ramp in NE quadrant.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

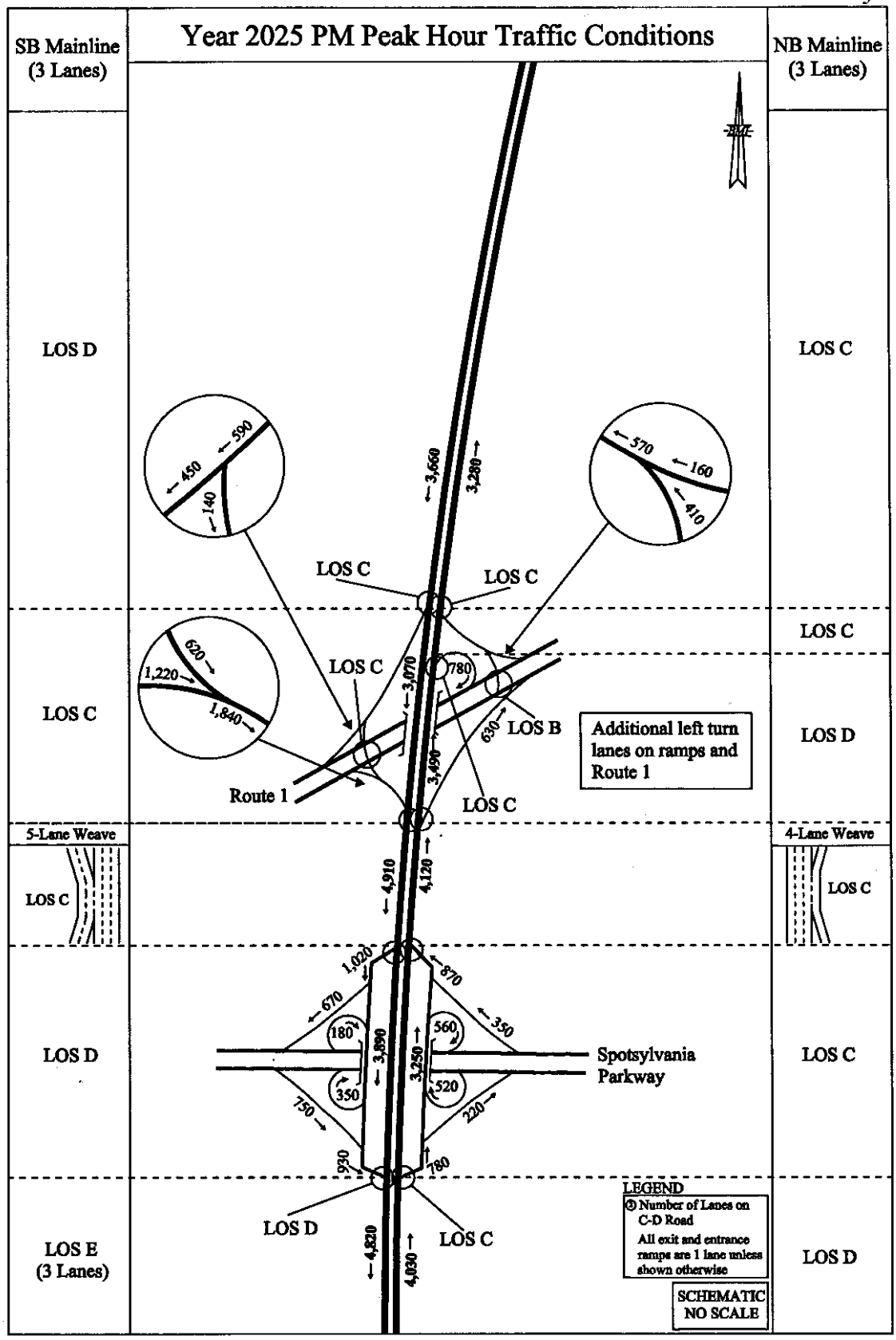


Figure 19. Scenario E-1

Table 14. Assessment Sheet for New Interchange Scenario E-2

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Spotsylvania Pkwy.
• Additional loop ramps in NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads connecting U.S. Route 1 and Spotsylvania Pkwy interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• The Spotsylvania Parkway and the U.S. Route 1 interchange are designed to meet AASHTO and VDOT geometric requirements.
• Continuous C-D roads through the U.S. Route 1 interchange improve safety on the mainline. Weaving movements are limited to the C-D roads only.
• Single exit access to C-D roads must be signed for two interchanges.
• Constructability of this concept and the maintenance and protection of traffic should not be a cause for concern.
• Additional right-of-way is required.</td><td>Construction Cost Index= 63</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way= 129</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage= Not estimated because option dropped</td></tr>
<tr><td>Affected Floodplain Acreage= Not estimated because option dropped</td></tr>
<tr><td>Traffic Assessment

• LOS F is projected at merge of C-D road on SB I-95 at Spotsylvania Parkway. This is proposed as a two-lane ramp.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)

• Single exits to C-D roads will need to have signing for two interchanges.
• Ramp from C-D road to SB I-95 south of Spotsylvania Pkwy operates at LOS F due primarily to the fact that this downstream section beyond the merge has only 3 SB lanes.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop
See Option E-3</td></tr>
</table>

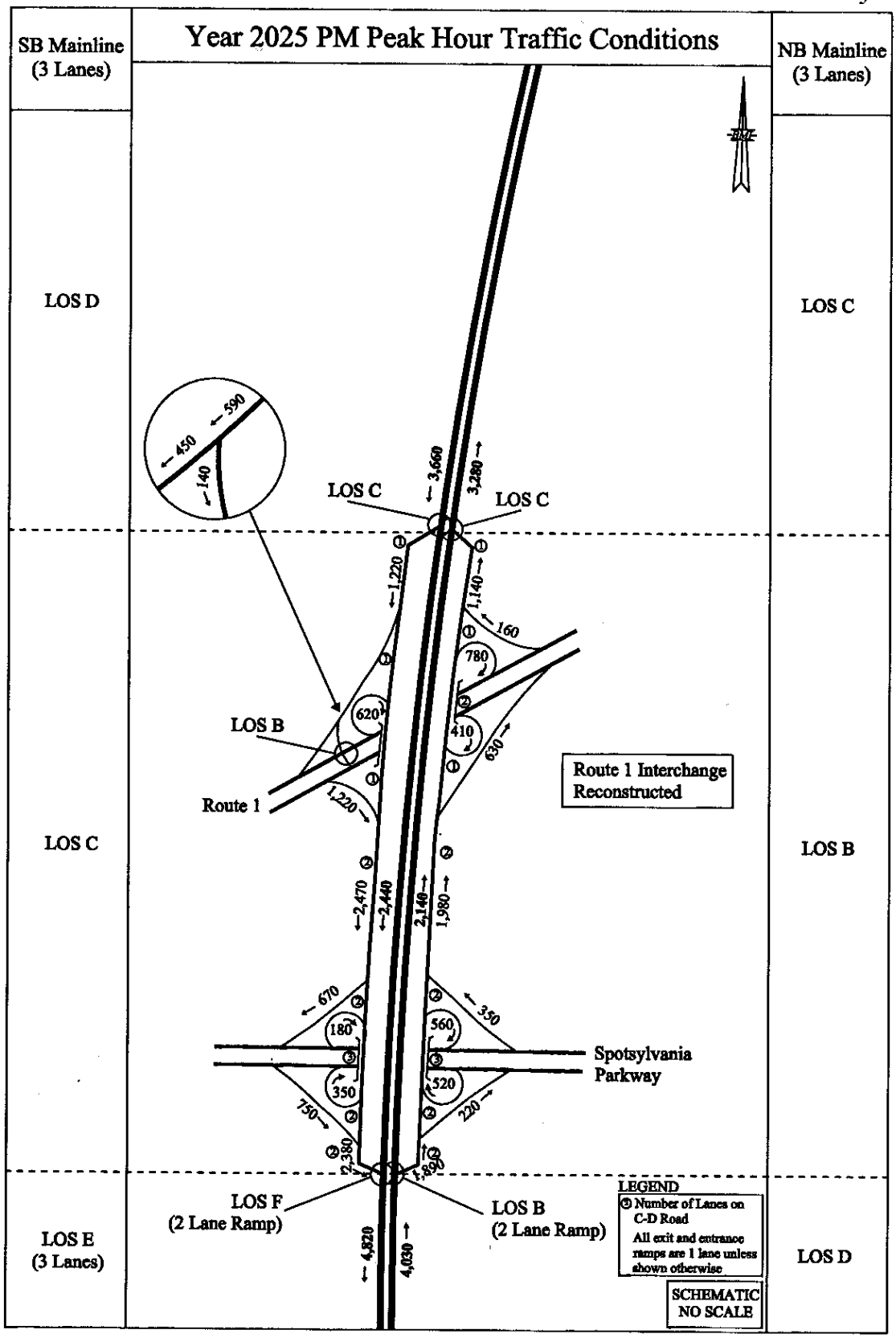


Figure 20. Scenario E-2

Table 15. Assessment Sheet for New Interchange Scenario E-3

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Spotsylvania Pkwy.
• Additional loop ramps in NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads connecting U.S. Route 1 and Spotsylvania Pkwy interchanges.
• NB and SB entrance and exit ramps between interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

Because of unacceptable weave sections on the mainline, this concept was dropped and no engineering plans were developed.</td><td>Construction Cost Index=
Estimate not prepared</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
Estimate not prepared</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
0.3</td></tr>
<tr><td>Affected Floodplain Acreage=
1.0</td></tr>
<tr><td>Traffic Assessment

• Even with the C-D road, a weaving area would be created on the mainline. A four-lane weaving area would operate at LOS F. Without the full auxiliary lane, the LOS for a thru freeway section would be LOS E.</td><td> 
Many locations at LOS F and/or unacceptable traffic conditions</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)

• Weaving on I-95 freeway mainline between Spotsylvania Pkwy and U.S. Route 1, which is not allowable by FHWA.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop See Option E-4</td></tr>
</table>

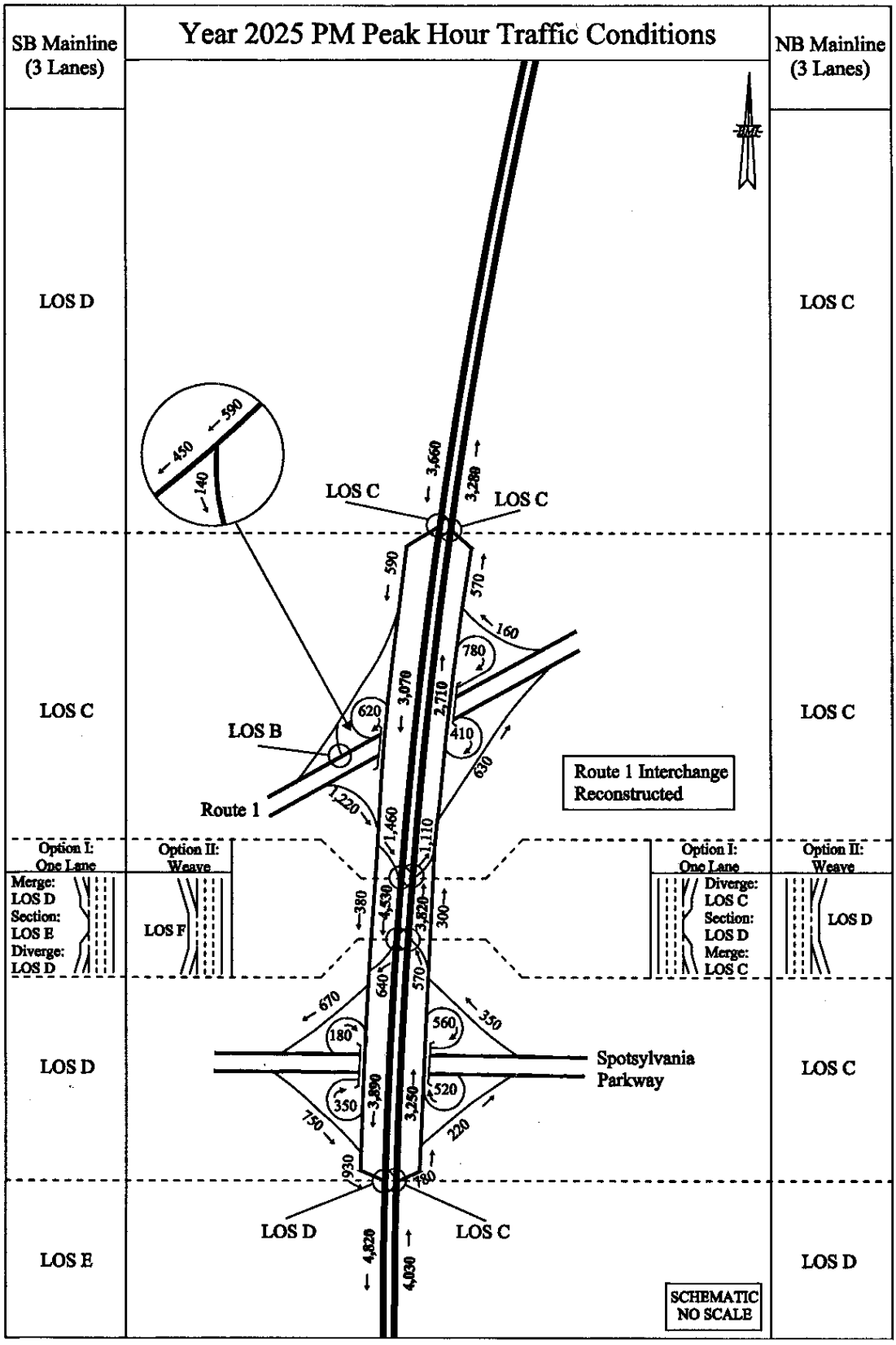


Figure 21. Scenario E-3

Table 16. Assessment Sheet for New Interchange Scenario E-4

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Spotsylvania Pkwy.
• Additional loop ramps in NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads connecting U.S. Route 1 and Spotsylvania Pkwy interchanges.
• NB and SB braided entrance and exit ramps between interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• The geometric elements of the C-D roads in the vicinity of the braided ramps could be influenced by the profiles of the braided ramps such that they would <u>not</u> meet AASHTO and VDOT requirements as proposed.
• Except for the bullet above, the geometric design of the Spotsylvania Parkway and the improvements to the U.S. Route 1 interchange meet applicable standards.
• The short weave sections in the vicinity of the braided ramps are a cause for safety concern.
• Although this concept is constructible, it requires a considerable amount of additional right-of-way.</td><td>Construction Cost Index=
71</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
152</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
1.2</td></tr>
<tr><td>Affected Floodplain Acreage=
3.6</td></tr>
<tr><td>Traffic Assessment

• LOS E conditions projected for SB I-95 south of the Spotsylvania Parkway interchange.
• Other locations projected to operate at acceptable LOS in PM peak period.</td><td> 
A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Braided ramps eliminate weaving on the mainline.
• Braided ramps create two short weaving sections between Spotsylvania Pkwy and U.S. Route 1 on both NB and SB C-D roads.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Option E-5</td></tr>
</table>

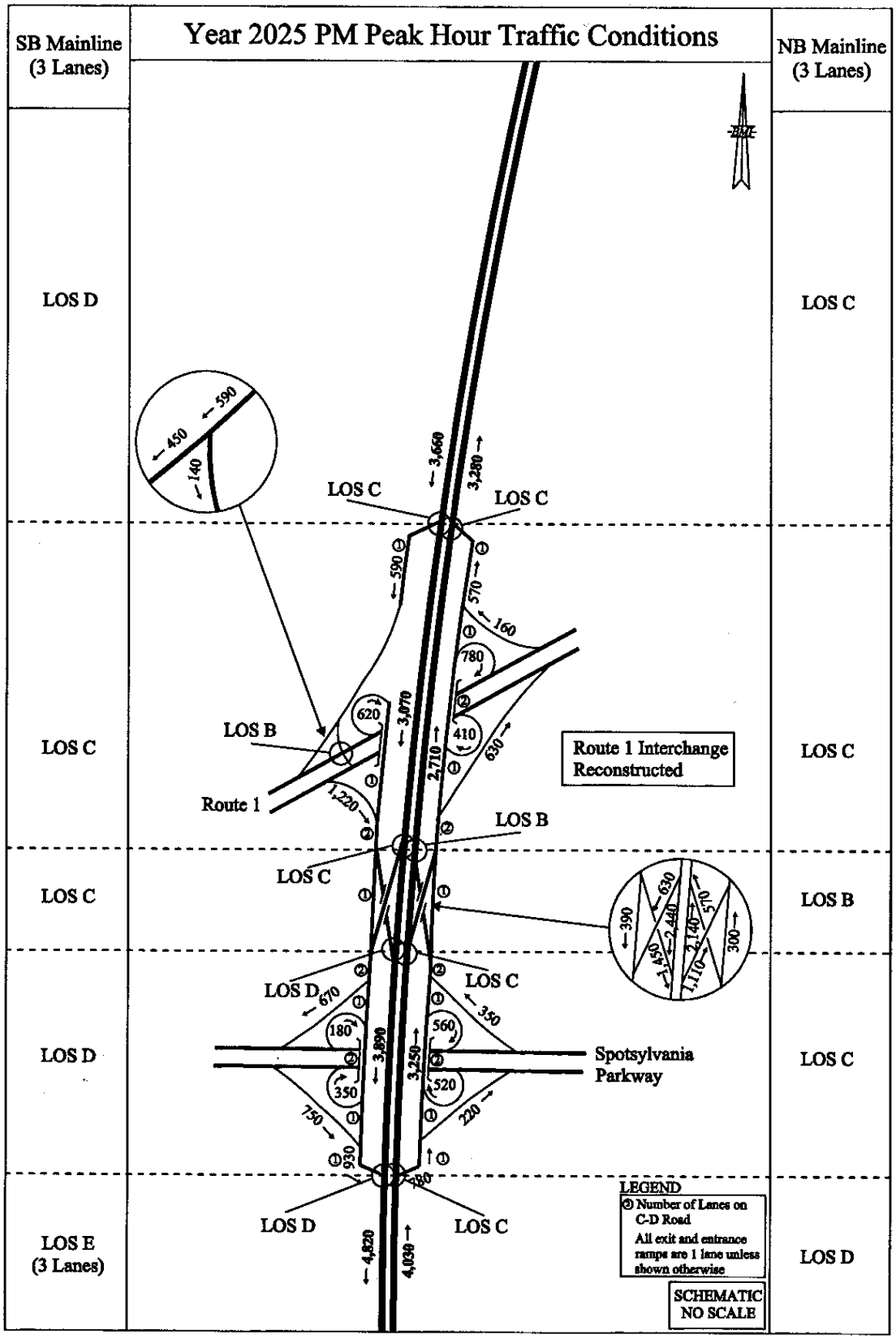


Figure 22. Scenario E-4

Table 17. Assessment Sheet for New Interchange Scenario E-5

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Spotsylvania Pkwy.
• Additional loop ramps in NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads connecting U.S. Route 1 and Spotsylvania Pkwy interchanges.
• NB and SB entrance and exit ramps between interchanges with weaving on the C-D roads (reverse of E-3).</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Although the geometric design of this concept meets AASHTO and VDOT requirements, the length of the weaving segments on the C-D roads between the two interchanges may not be sufficient for high volumes of traffic.
• Construction or maintenance of traffic would not be a major issue affecting this concept.
• Additional right-of-way is required.</td><td>Construction Cost Index=
60</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
141</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
1.1</td></tr>
<tr><td>Affected Floodplain Acreage=
1.8</td></tr>
<tr><td>Traffic Assessment

• Weaving section on C-D road.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Additional slip ramps facilitate individual exits for each interchange.
• Weaving occurs on C-D road rather than mainline, but high weaving volumes on C-D road may cause traffic problems.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

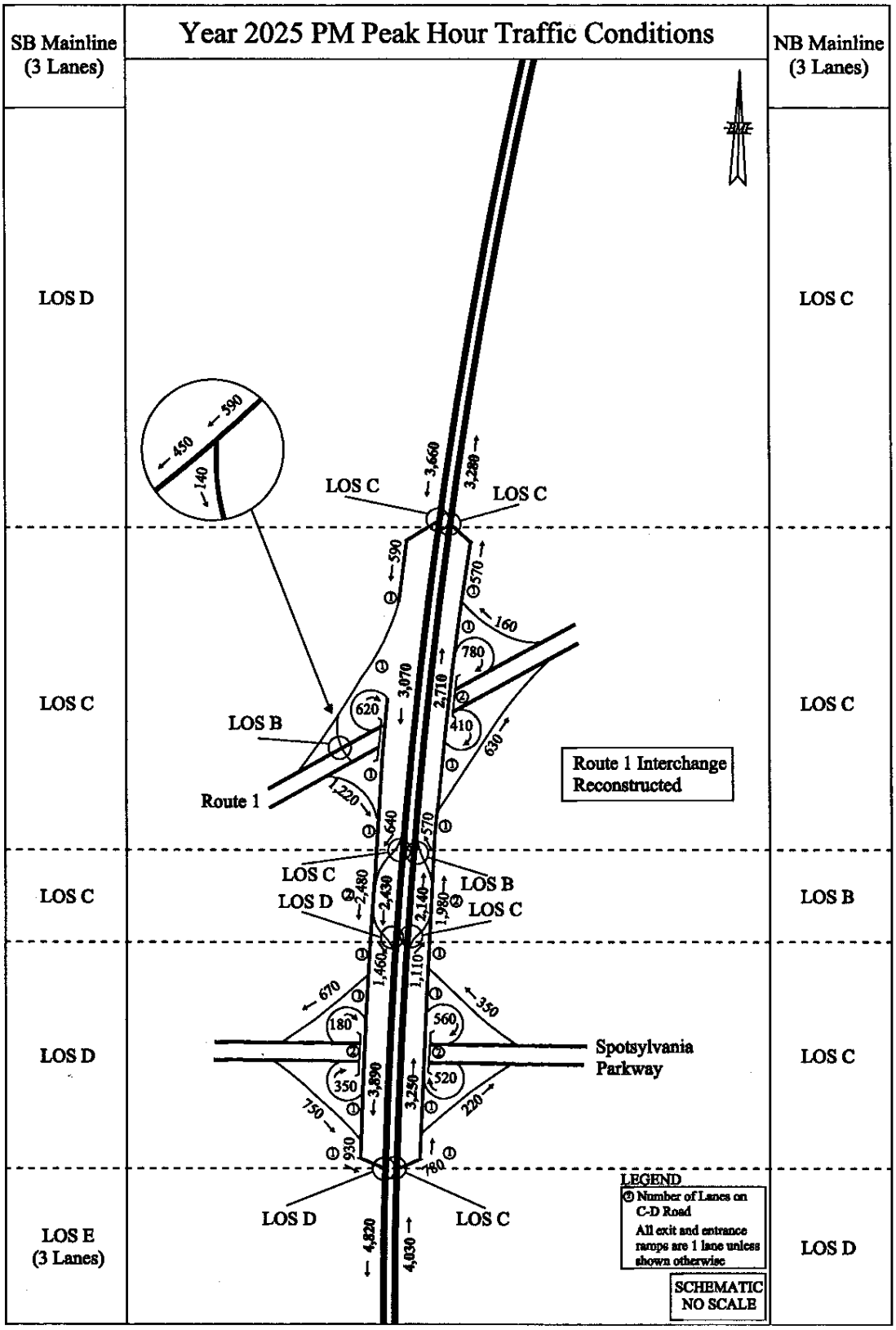


Figure 23. Scenario E-5

Table 18. Assessment Sheet for New Interchange Scenario F

<table>
<tr><td colspan="2">Description of Concept</td></tr>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Rather than geometrically improve the U.S. Route 1 interchange, it was thought that access to I-95 at U.S. Route 1 could be closed. It was thought that existing geometry at the U.S. Route 1 interchange was below current design standards and would not be able to accommodate traffic at acceptable levels of service. Furthermore, it was thought that the new interchange at Spotsylvania Parkway could accommodate the increased traffic and I-95 would operate far more efficiently without two interchanges in close proximity.</td></tr>
<tr><td rowspan="3">Engineering Assessment

Because of unacceptable weave sections on the mainline, this concept was dropped and no engineering plans were developed.</td><td>Construction Cost Index=
Estimate not prepared</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
Estimate not prepared</td></tr>
<tr><td rowspan="2">Environmental Features Present

No features in the vicinity of the I-95/Spotsylvania Parkway interchange identified on the basis of available mapping.</td><td>Affected Wetland Acreage=
Not estimated because option dropped</td></tr>
<tr><td>Affected Floodplain Acreage=
Not estimated because option dropped</td></tr>
<tr><td>Traffic Assessment

• LOS F conditions projected for two-lane merge on SB I-95 during PM peak period.</td><td> 
Many locations at LOS F and/or unacceptable traffic conditions</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Substantially higher volumes projected for the loop ramp in the NE, NW, and SE quadrants and the outer ramps in the SE and SW quadrants compared to Scenario E.
• Traffic flow would be worse compared to Scenario E.
• Potential adverse traffic impacts on junction of U.S. Route 1 and Spotsylvania Parkway.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop</td></tr>
</table>

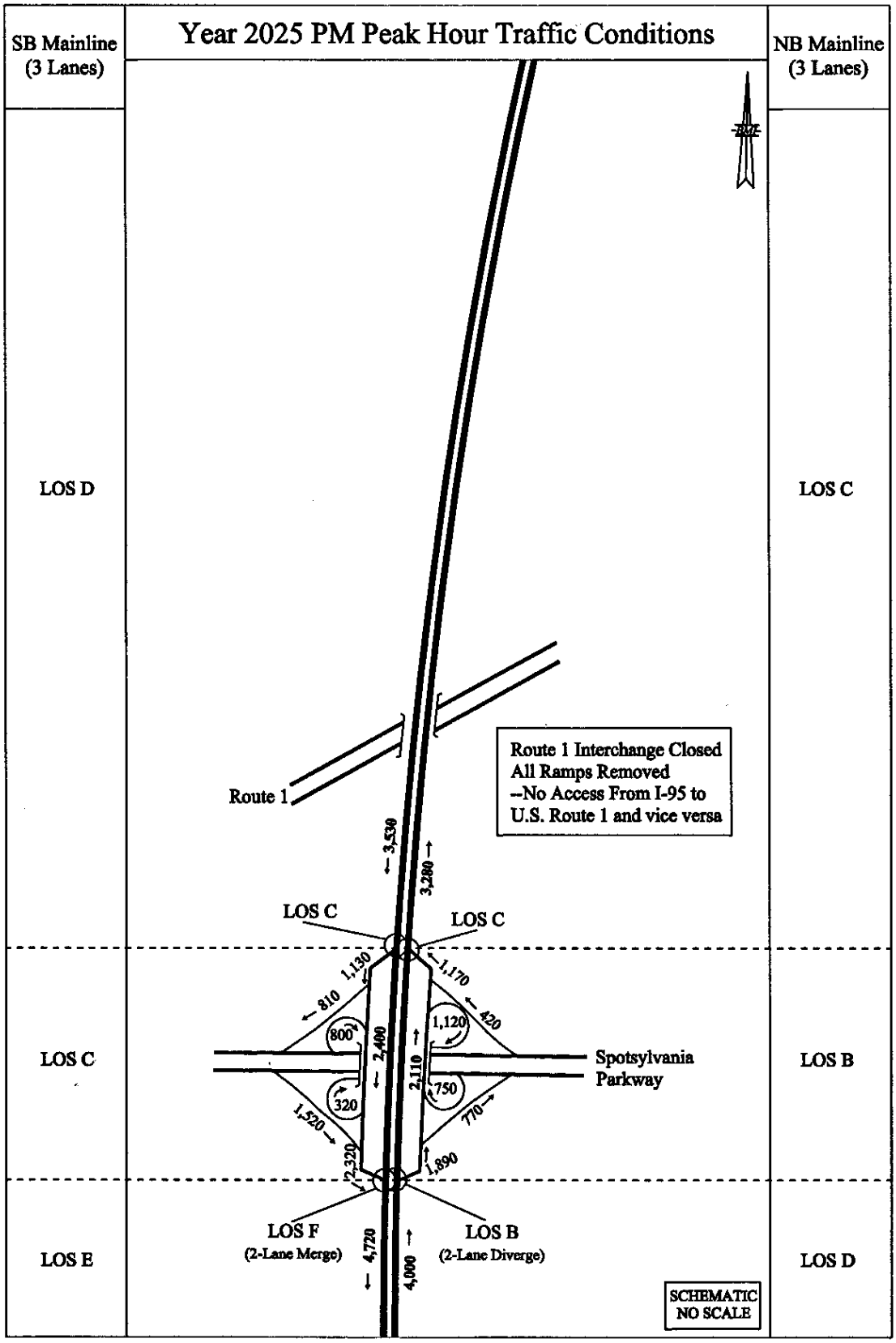


Figure 24. Scenario F

Table 19. Assessment Sheet for New Interchange Scenario G-1

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Provision of another new interchange at Route 208 would result in additional reduction in congestion at the Route 3 interchange.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
• Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• The weaving distance on the NB C-D roads between U.S. Route 1 and Route 208 may not be sufficient for high volumes of traffic.
• Single exit access to C-D roads must be signed for two interchanges.
• The improvements are constructible and should not have any maintenance and protection of traffic implications.
• The concept has additional right-of-way impacts.</td><td>Construction Cost Index=
90</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
198</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
0.2</td></tr>
<tr><td>Affected Floodplain Acreage=
2.1</td></tr>
<tr><td>Traffic Assessment

• Generally acceptable LOS conditions projected for PM peak period.
• Five-lane weave section would be required for SB I-95 between U.S. Route 1 and Spotsylvania Parkway.</td><td> 
Many locations at LOS F and/or unacceptable traffic conditions</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)

• Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
• Single exit will need to have signing for two interchanges.
• Weaving on the mainline between Spotsylvania Pkwy and U.S. Route 1 interchanges – 4 lanes needed NB and 5 lanes needed SB.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop
See Option G-2</td></tr>
</table>

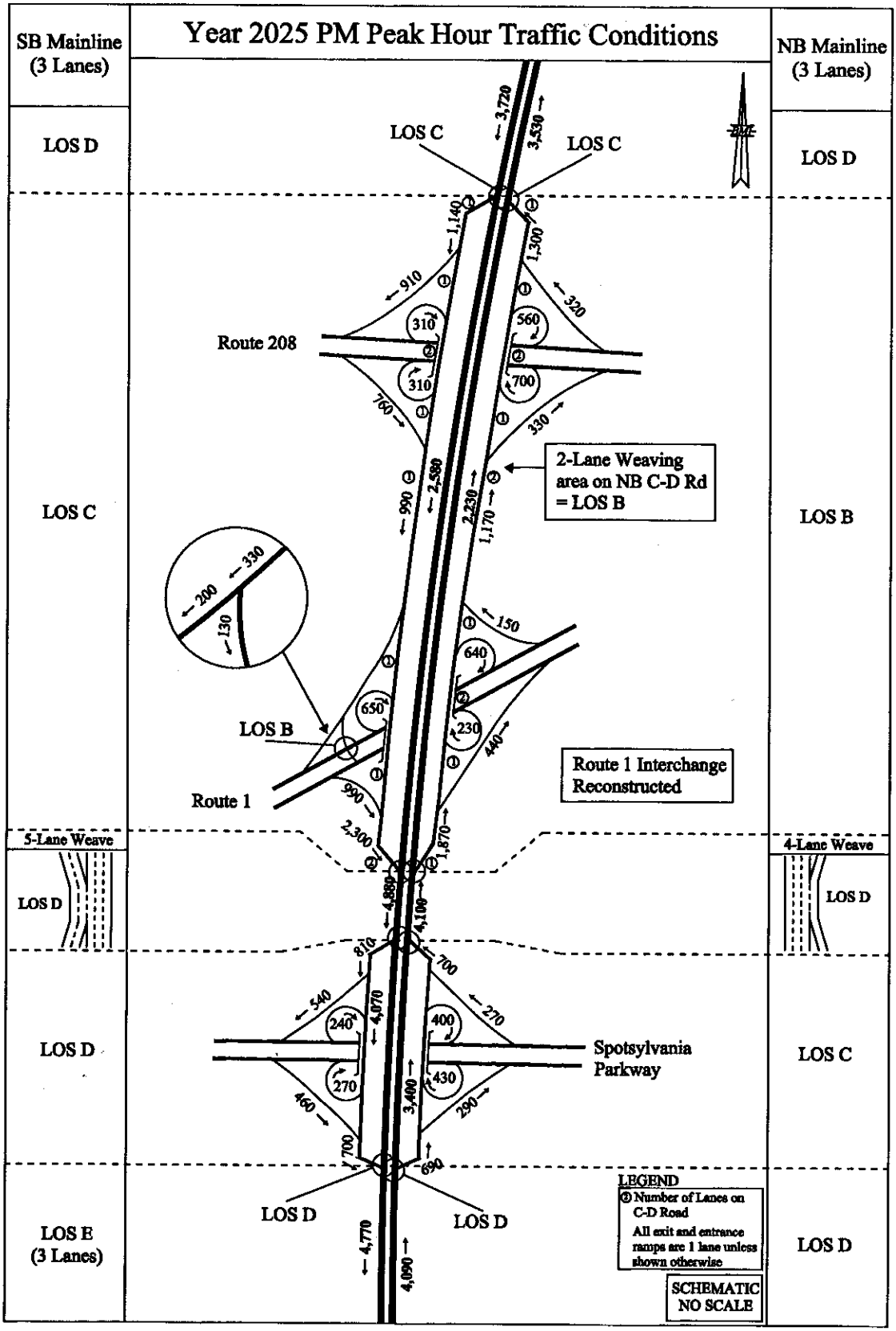


Figure 25. Scenario G-1

Table 20. Assessment Sheet for New Interchange Scenario G-2

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Provision of another new interchange at Route 208 would result in additional reduction in congestion at the Route 3 interchange</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
• Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges.
• Continuous C-D roads connect the three interchanges with no slip ramps.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Although the geometric design of this concept meets AASHTO & VDOT requirements, the length of weaving segments on the C-D roads may not be sufficient for the volume of traffic.
• Single exit access to C-D roads must be signed for three interchanges.
• This concept is constructible and maintaining traffic should not be a problem.
• Additional right-of-way is required.</td><td>Construction Cost Index=
90</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
198</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
1.5</td></tr>
<tr><td>Affected Floodplain Acreage=
4.8</td></tr>
<tr><td>Traffic Assessment

• LOS F conditions projected for two-lane merge on SB I-95 where SB C-D merges onto I-95.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)

• Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
• Single exit will need to have signing for three interchanges – potentially confusing.
• Ramp from C-D road to SB I-95 south of Spotsylvania Pkwy operates at LOS F due primarily to the fact that this section only has 3 SB lanes.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop
See Option G-3</td></tr>
</table>

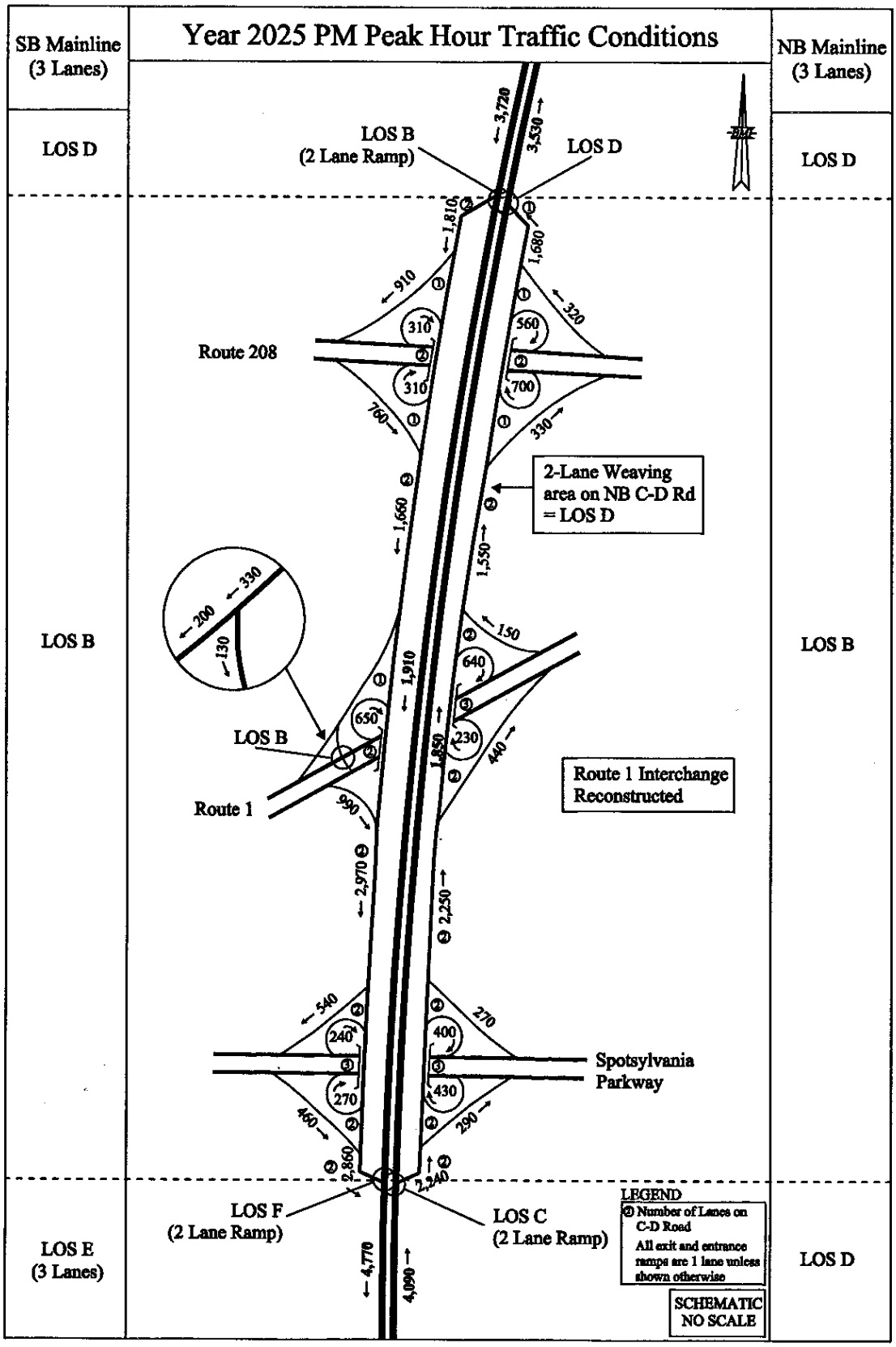


Figure 26. Scenario G-2

Table 21. Assessment Sheet for New Interchange Scenario G-3

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Provision of another new interchange at Route 208 would result in additional congestion at the Route 3 interchange.</td></tr>
<tr><td colspan="2">Description

• Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
• Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges.
• NB and SB braided entrance and exit ramps between U.S. Route 1 and Spotsylvania Pkwy interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards.
• The geometric elements in the vicinity of the braided ramps are barely adequate as proposed. The profiles of the braided ramps may further aggravate the situation.
• The length of weaving segments on C-D roads may not be sufficient for high volumes of traffic.
• Single exit access to C-D roads must be signed for two interchanges.
• Although the concept is constructible, it requires a considerable amount of additional right-of-way.</td><td>Construction Cost Index=
99</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
221</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
1.5</td></tr>
<tr><td>Affected Floodplain Acreage=
4.8</td></tr>
<tr><td>Traffic Assessment

• Generally acceptable 2025 PM peak hour LOS at all locations except the section of SB I-95 south of Spotsylvania Parkway (LOS E).</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
• Single exit will need to have signing for two interchanges.
• Braided ramps create weaving sections on C-D roads.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Option G-4</td></tr>
</table>

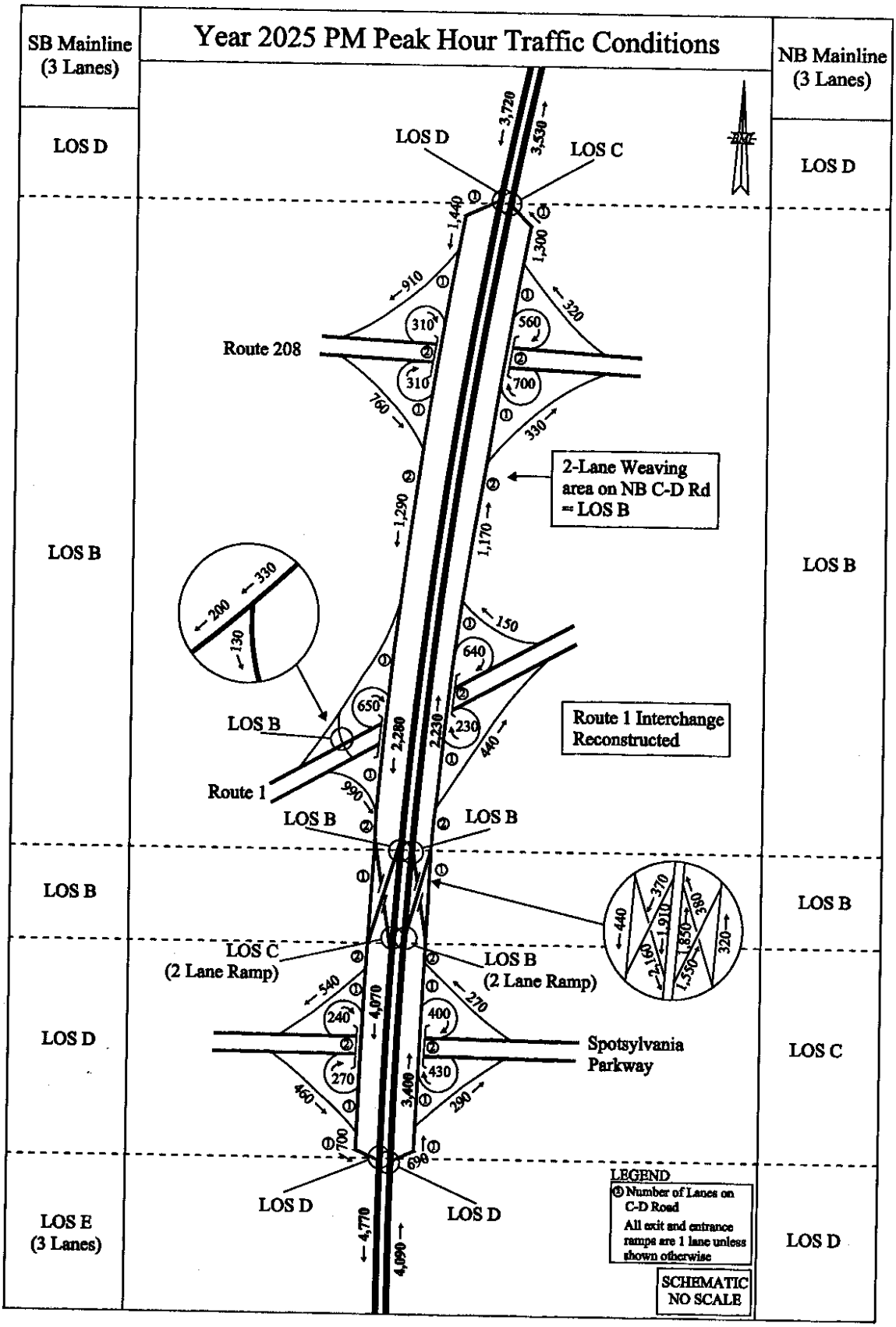


Figure 27. Scenario G-3

Table 22. Assessment Sheet for New Interchange Scenario G-4

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Provision of another new interchange at Route 208 would result in additional congestion at the Route 3 interchange.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
• Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges.
• NB and SB braided entrance and exit ramps between U.S. Route 1 and Spotsylvania Pkwy interchanges.
• NB and SB exit ramps between Route 208 and U.S. Route 1 interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT standards. However, the geometric elements on the C-D roads barely meet the minimum requirements, especially the length of the weaving segments on the NB C-D road south of Route 208.
• The geometric features in the vicinity of the braided ramps barely meet the minimum requirements and could be influenced by the profile of the braided ramps such that they would not meet the applicable standards.
• Although the concept is constructible, it requires a considerable amount of additional right-of-way.</td><td>Construction Cost Index=
99</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
228</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
1.5</td></tr>
<tr><td>Affected Floodplain Acreage=
4.8</td></tr>
<tr><td>Traffic Assessment

• Generally acceptable 2025 PM peak hour LOS at all locations except the section of SB I-95 south of Spotsylvania Parkway (LOS E).</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
• Separate exit ramp for each interchange.
• Braided ramps create several weaving sections on C-D roads.
• NB and SB slip ramps between Route 208 and U.S. Route 1 create weaving sections on the C-D roads.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance</td></tr>
</table>

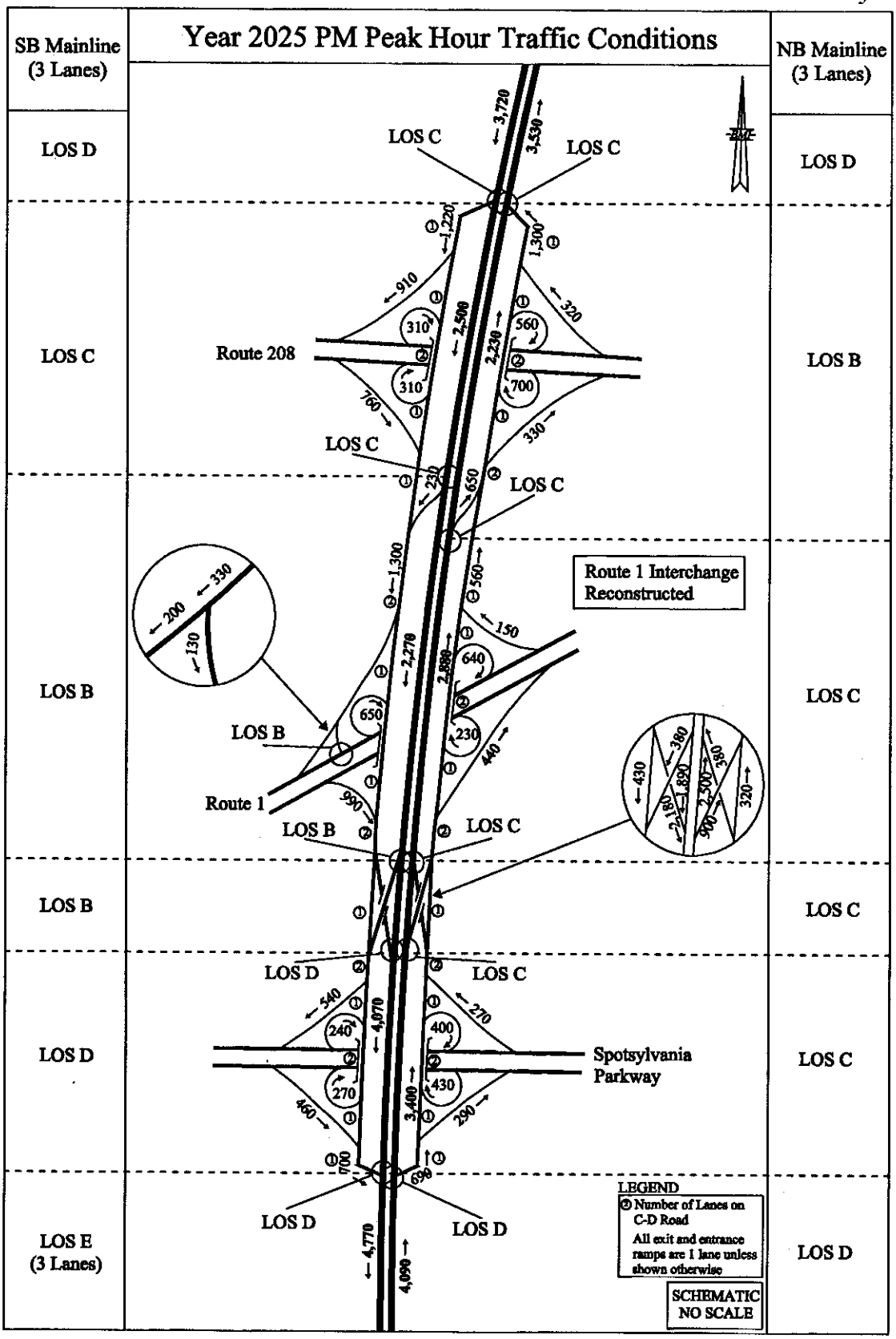


Figure 28. Scenario G-4

Table 23. Assessment Sheet for New Interchange Scenario G-5A

<table>
<tr><td colspan="2">Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction

Provision of another new interchange at Route 208 would result in additional congestion at the Route 3 interchange</td></tr>
<tr><td colspan="2">Description of Concept
• Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
• Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
• C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges
• No left turns permitted at the U.S. Route 1 interchange.</td></tr>
<tr><td rowspan="2">Engineering Assessment
• Geometric design meets applicable standards.
• Closure of four movements requires justification, which may not be politically feasible.
• Closure of four movements may also cause confusion to motorists, which could become a safety issue.
• The concept is constructable and it requires additional ROW.
• Single exit must be signed for three interchanges.
• Geometric layout allows for missing movements to be added in the future.</td><td>Construction Cost Index=
88</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
197</td></tr>
<tr><td rowspan="2">Environmental Features Present

• Wetlands and floodplains near U.S. Route 1/I-95 interchange.</td><td>Affected Wetland Acreage=
0.4</td></tr>
<tr><td>Affected Floodplain Acreage=
1.6</td></tr>
<tr><td>Traffic Assessment

• LOS F projected for 2025 PM peak hour at two-lane merge of SB C-D road and SB I-95</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)
• Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
• Single exit will need to have signing for two interchanges – potentially confusing.
• No left turns at U.S. Route 1 presents a political challenge and puts additional pressure on the intersections of U.S. Route 1 with Route 208 and Spotsylvania Pkwy.
• Ramp from C-D road to SB I-95 south of Spotsylvania Pkwy operates at LOS F due primarily to the fact that this section only has 3 SB lanes.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop
See Option G-5B</td></tr>
</table>

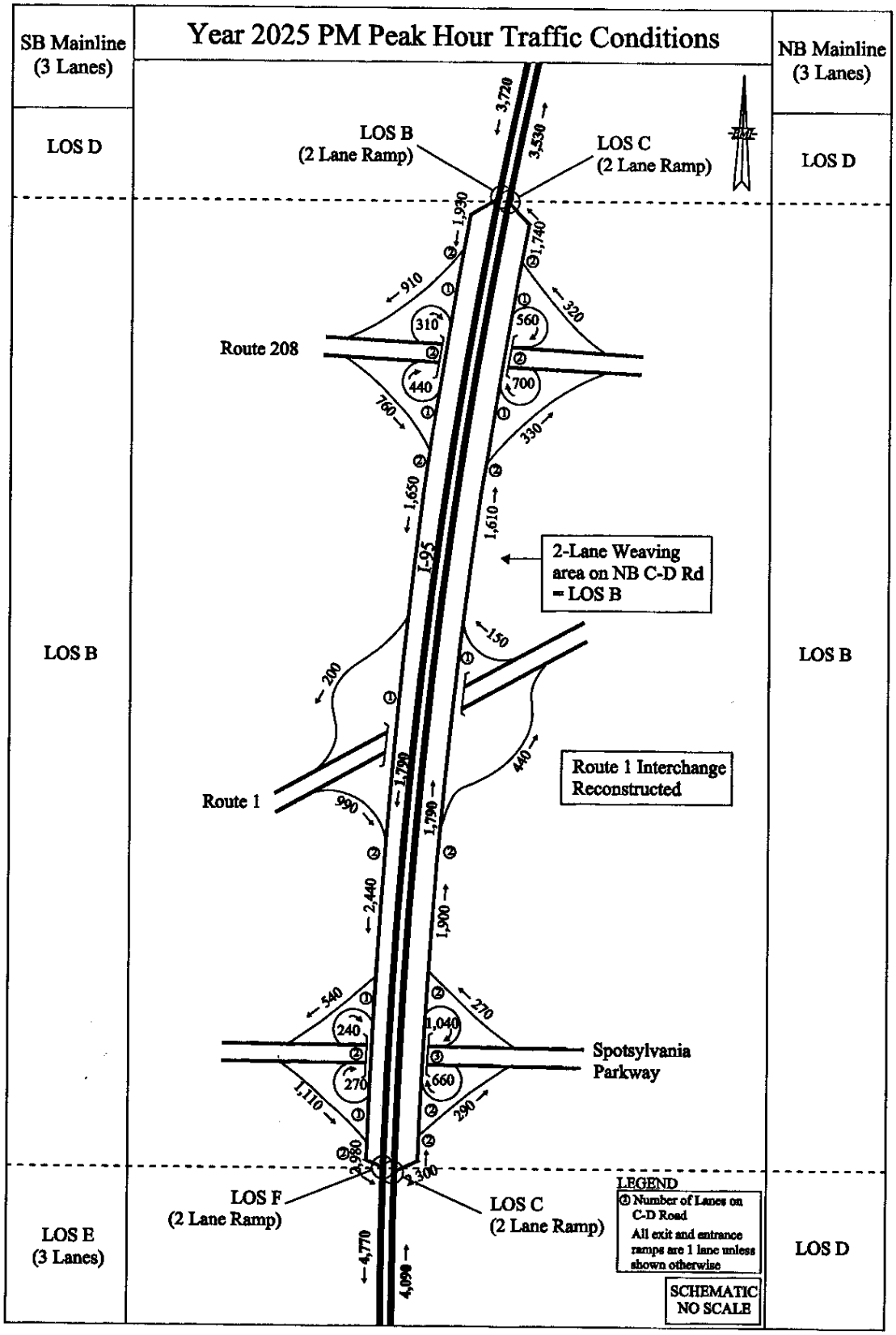


Figure 29. Scenario G-5A

Table 24. Assessment Sheet for New Interchange Scenario G-5B

Rationale for Scenario

Provision of a new interchange for planned Spotsylvania Parkway would serve existing and planned development in Spotsylvania County and reduce congestion at U.S. Route 1 interchange. Improvements at U.S. Route 1 interchange would further reduce congestion and enhance safety at this junction.

Provision of another new interchange at Route 208 would result in additional congestion at the Route 3 interchange.

Description

- Full cloverleaf interchanges at Spotsylvania Pkwy and Route 208.
- Additional loop ramps in the NW and SE quadrants of U.S. Route 1 interchange.
- C-D roads at Spotsylvania Pkwy, and connecting Route 208 and U.S. Route 1 interchanges.
- No left turns permitted at the U.S. Route 1 interchange.

Engineering Assessment

- Geometric design meets applicable standards.
- Closure of four movements requires justification, which may not be politically feasible.
- Closure of four movements may also cause confusion to motorists, which could become a safety issue.
- The concept is constructable and it requires additional ROW.
- Single exit must be signed for three interchanges.

Construction Cost Index= 87

Needed Additional Acreage for Right-of-Way= 169

Environmental Features Present

- Wetlands and floodplains near U.S. Route 1/I-95 interchange.

Affected Wetland Acreage= 0.3

Affected Floodplain Acreage= 0.6

Traffic Assessment

- LOS F projected for 2025 PM peak hour at two-lane merge of SB C-D road and SB I-95.

A few isolated locations at LOS F

Critical Assessment of Improvement (*Fatal Flaws are Italicized*)

- Three interchanges present spacing/safety concerns; FHWA has voiced concerns about three closely spaced interchanges.
- Single exit will need to have signing for two interchanges – potentially confusing.
- No left turns at U.S. Route 1 presents a political challenge and puts additional pressure on the intersections of U.S. Route 1 with Route 208 and Spotsylvania Pkwy.
- *Ramp from C-D road to SB I-95 south of Spotsylvania Pkwy operates at LOS F due primarily to the fact that this section only has 3 SB lanes.*

Recommendation for Further Study? **Drop**

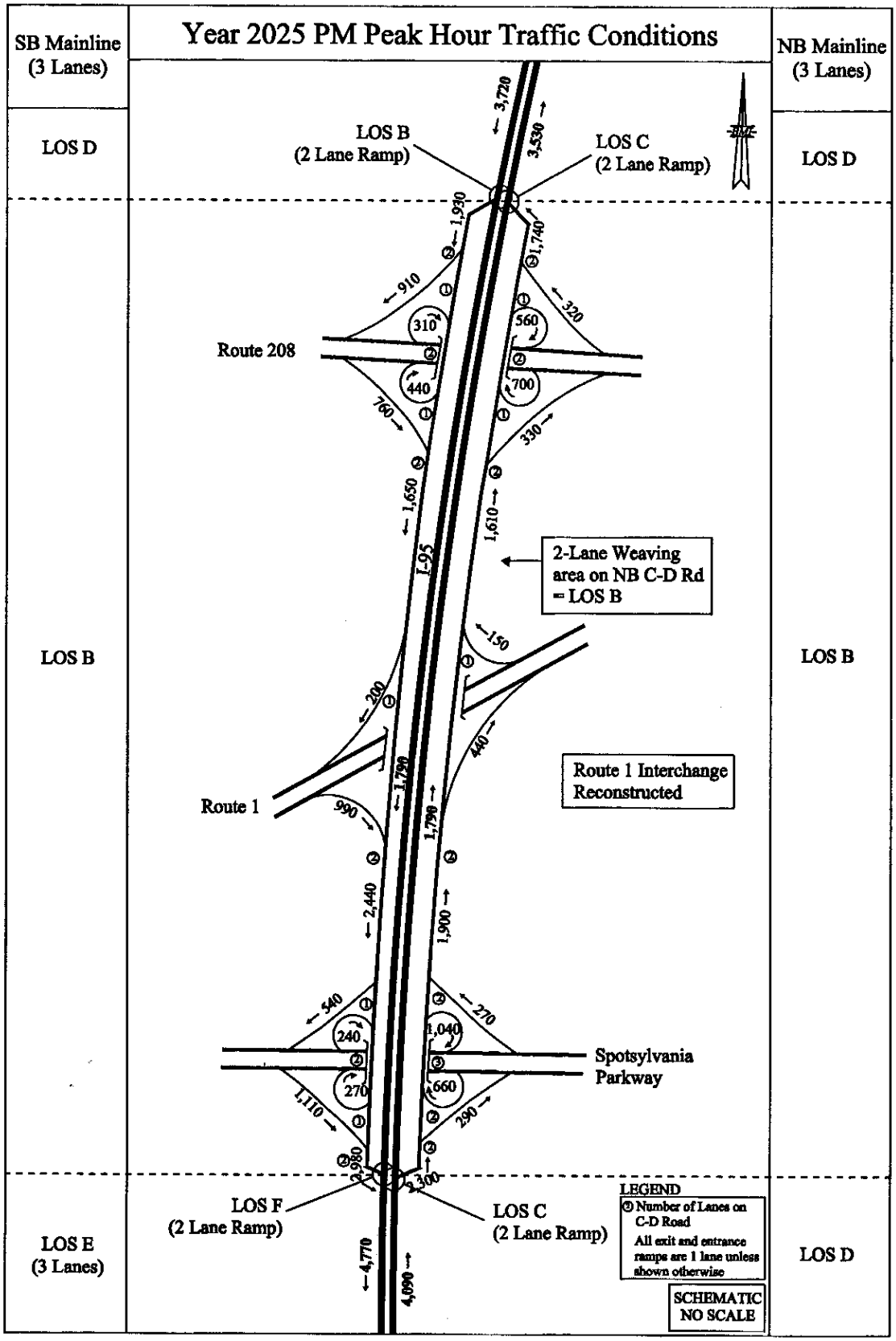


Figure 30. Scenario G-5B

Table 25. Assessment Sheet for New Interchange Scenario H-1

<table>
<tr><td colspan="2">Rationale for Scenario

Given the close proximity of Route 208, U.S. Route 1 and Spotsylvania Parkway (i.e., three interchanges within 2 ½ miles), it was thought that traffic flow on I-95 would operate better if there were two new interchanges at Route 208 and Spotsylvania Parkway and access at U.S. Route 1 was closed compared to the three interchanges scenario.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Route 208 and Spotsylvania Pkwy with C-D roads connecting the two interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• The geometric design meets AASHTO and VDOT standards.
• Continuous C-D roads between two generously spaced interchanges improves traffic safety.
• Simple to construct.
• Single exit to sign two lanes.
• Additional right-of-way required.
• Closure of U.S. Route 1 needs justification.</td><td>Construction Cost Index=
84</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
162</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
No impacts</td></tr>
<tr><td>Affected Floodplain Acreage=
No impacts</td></tr>
<tr><td>Traffic Assessment

• LOS F projected for the two-lane merge on SB I-95 where the C-D road merges back onto SB I-95.
• As with many other concepts, LOS E projected for SB I-95 south of Spotsylvania Parkway.</td><td> 
A few isolated locations at LOS F</td></tr>
<tr><td colspan="2">Critical Assessment (Fatal Flaws are Italicized)

• Political challenge to remove U.S. Route 1 interchange.
• Single exit will need to have signing for two interchanges.
• Ramp from C-D road to SB I-95 south of Spotsylvania Pkwy operates at LOS F due primarily to the fact that this section only has 3 SB lanes.
• Completely eliminates weaving on both the mainline and C-D roads.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop
See Option H-2</td></tr>
</table>

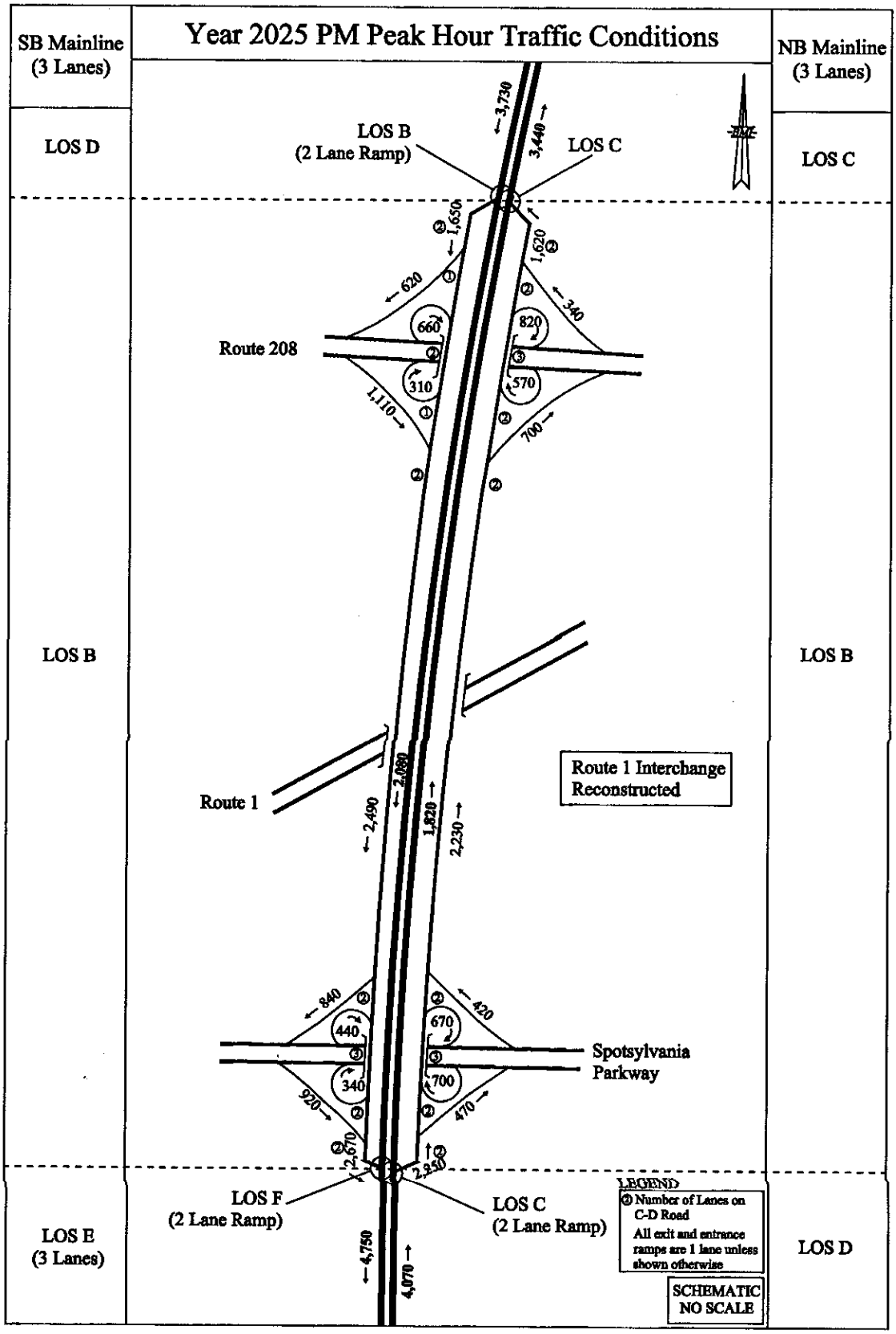


Figure 31. Scenario H-1

Table 26. Assessment Sheet for New Interchange Scenario H-2

<table>
<tr><td colspan="2">Rationale for Scenario

Given the close proximity of Route 208, U.S. Route 1 and Spotsylvania Parkway (i.e., three interchanges within 2 ½ miles), it was thought that traffic flow on I-95 would operate better if there were two new interchanges at Route 208 and Spotsylvania Parkway and access at U.S. Route 1 was closed compared to the three new interchanges scenario.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Route 208 and Spotsylvania Pkwy with C-D roads connecting the two interchanges.
• NB and SB entrance and exit ramps between interchanges.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO and VDOT requirements.
• Continuous C-D roads between two generously spaced interchanges and slip ramp exits and entrances would improve traffic safety and flow.
• No major construction or signing problems will be faced on this concept.
• Additional right-of-way required.</td><td>Construction Cost Index=
89</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
163</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
No impacts</td></tr>
<tr><td>Affected Floodplain Acreage=
No impacts</td></tr>
<tr><td>Traffic Assessment

• Concerns about the ability of a two-lane SB C-D road to accommodate the weaving flows. The results of the application of HCM LOS procedures, which are appropriate for freeways, suggest poor operations. As with other concepts, LOS E conditions projected for SB I-95, south of Spotsylvania Parkway.</td><td> 
A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment

• Political challenge to remove U.S. Route 1 interchange.
• All ramps operate at LOS C or better with the exception of the NB I-95 off-ramp to the C-D road.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Option H-3</td></tr>
</table>

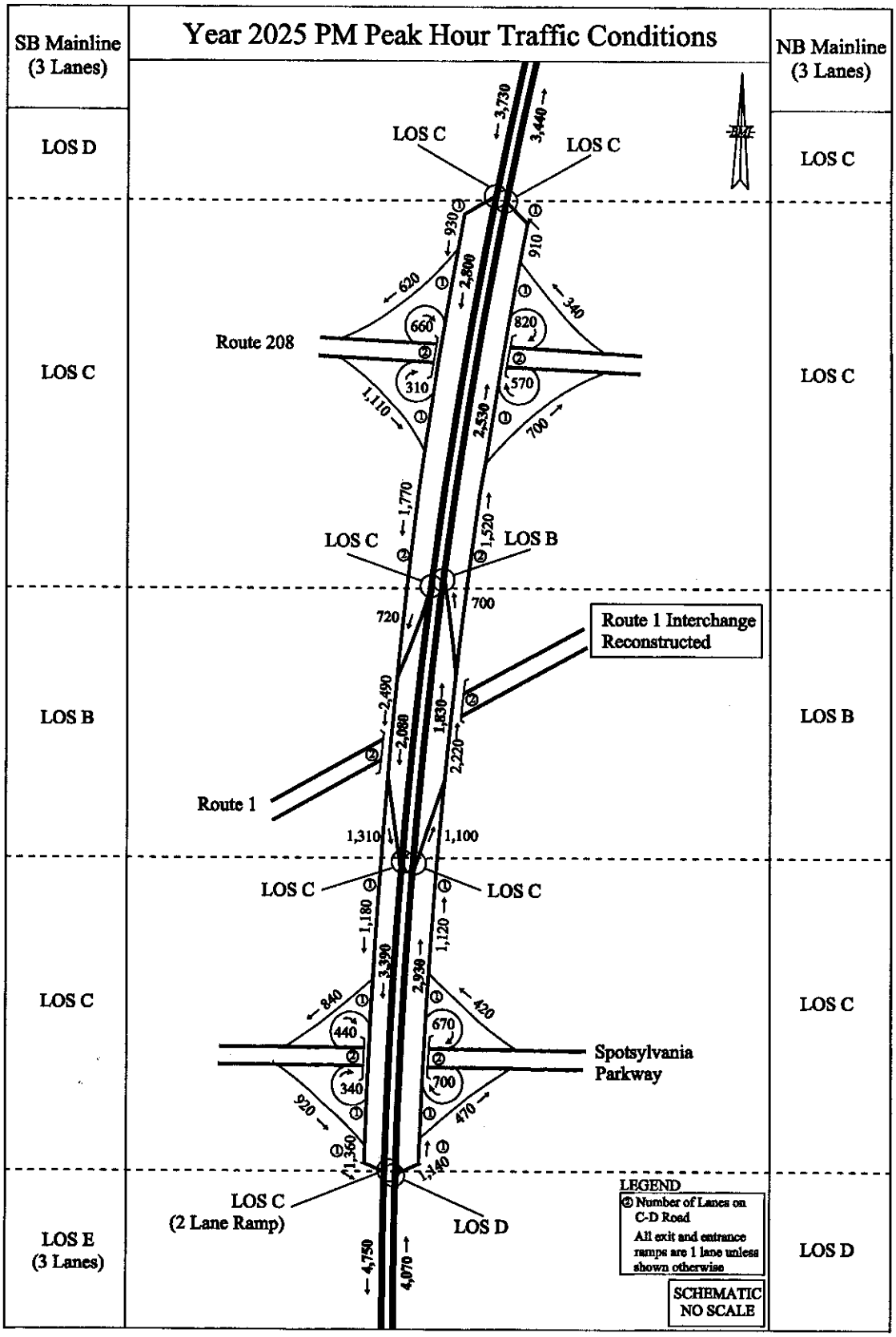


Figure 32. Scenario H-2

Table 27. Assessment Sheet for New Interchange Scenario H-3

<table>
<tr><td colspan="2">Rationale for Scenario

Given the close proximity of Route 208, U.S. Route 1 and Spotsylvania Parkway (i.e., three interchanges within 2 ½ miles), it was thought that traffic flow on I-95 would operate better if there were two new interchanges at Route 208 and Spotsylvania Parkway and access at U.S. Route 1 was closed compared to the three new interchanges scenario.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchanges with C-D roads at Route 208 and Spotsylvania Pkwy.</td></tr>
<tr><td rowspan="2">Engineering Assessment

• Geometric design meets AASHTO & VDOT standards.
• Continuous C-D roads between two generously spaced interchanges is not mandated by standards.
• This concept is simple to construct and has no signing problems.
• Additional right-of-way required.
• Closure of U.S. Route 1 needs justification.</td><td>Construction Cost Index=
77</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
162</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
No impacts</td></tr>
<tr><td>Affected Floodplain Acreage=
No impacts</td></tr>
<tr><td>Traffic Assessment

• Without a 4th SB auxiliary lane, LOS E conditions are projected from SB I-95 mainline section between Route 208 and Spotsylvania Parkway. If SB I-95 was widened to include a 4th auxiliary lane, LOS improves to C.</td><td> 
A few isolated locations at LOS E</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement

• Auxiliary lane required on SB mainline between Route 208 and Spotsylvania Pkwy due to potential weaving.
• Political challenge to remove U.S. Route 1 interchange.
• 3 merge/diverge areas operate at LOS D.
• Least expensive option ($15M less than H-2).</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Advance
Also see Option H-4</td></tr>
</table>

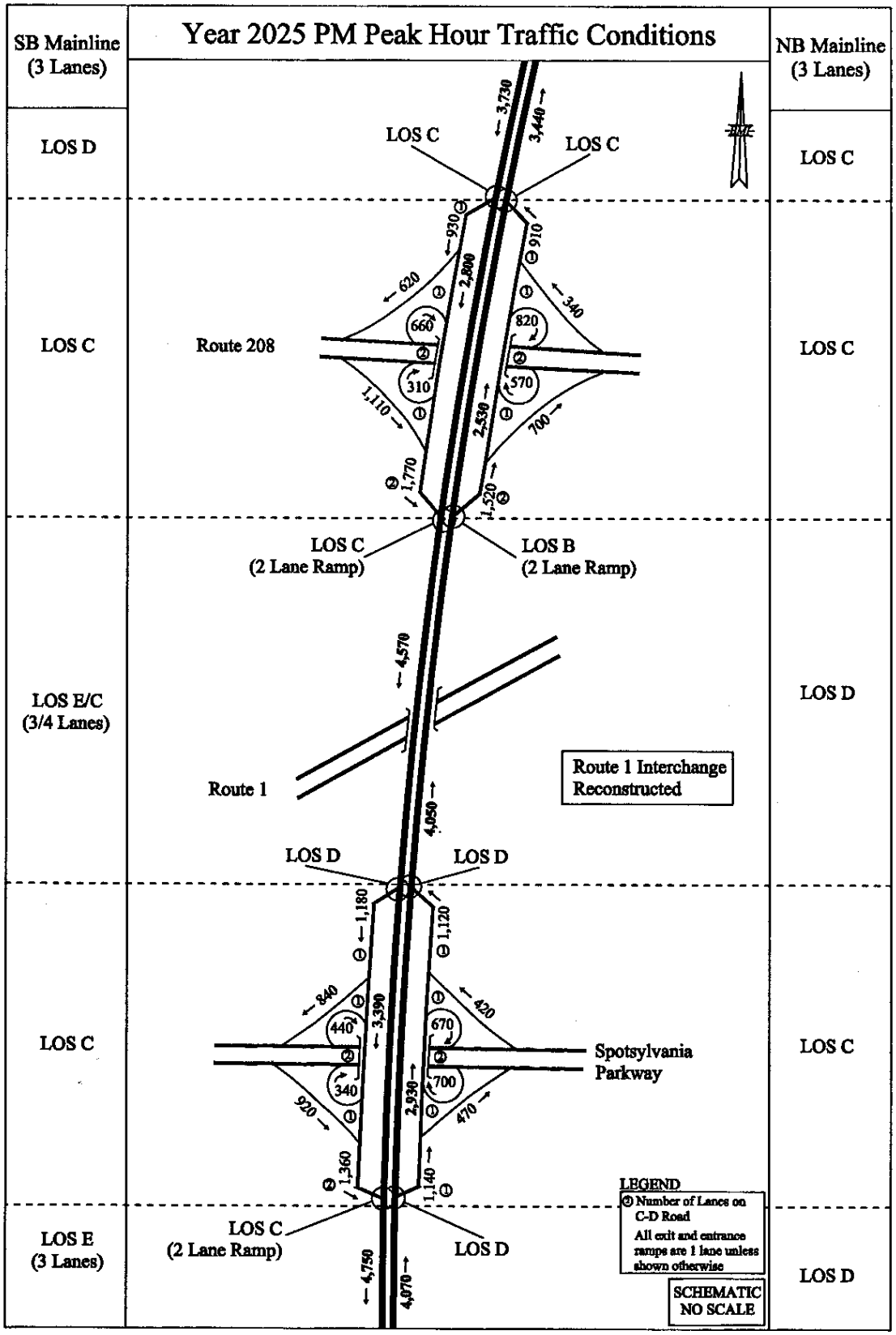


Figure 33. Scenario H-3

Table 28. Assessment Sheet for New Interchange Scenario H-4

<table>
<tr><td colspan="2">Rationale for Scenario

Given the close proximity of Route 208, U.S. Route 1 and Spotsylvania Parkway (i.e., three interchanges within 2 ½ miles), it was thought that traffic flow on I-95 would operate better if there were two new interchanges at Route 208 and Spotsylvania Parkway and access at U.S. Route 1 was closed compared to the three new interchanges scenario.</td></tr>
<tr><td colspan="2">Description of Concept

• Full cloverleaf interchange at Route 208 and Spotsylvania Pkwy with C-D roads connecting the two interchanges;
• NB and SB entrance and exit ramps between interchanges (reverse of H-2).</td></tr>
<tr><td rowspan="2">Engineering Assessment

Because of unacceptable weave sections on the mainline, this concept was dropped and no engineering plans were developed.</td><td>Construction Cost Index=
Estimate not prepared</td></tr>
<tr><td>Needed Additional Acreage for Right-of-Way=
Estimate not prepared</td></tr>
<tr><td rowspan="2">Environmental Features Present

None identified based on available mapping.</td><td>Affected Wetland Acreage=
No impacts</td></tr>
<tr><td>Affected Floodplain Acreage=
No impacts</td></tr>
<tr><td>Traffic Assessment

• Despite the projected LOS being generally acceptable, weaving area would be created on both NB and SB I-95 between Route 208 and Spotsylvania Parkway. This is unacceptable to FHWA.</td><td> 
Many locations at LOS F and/or unacceptable traffic conditions</td></tr>
<tr><td colspan="2">Critical Assessment of Improvement (Fatal Flaws are Italicized)

• Political challenge to remove U.S. Route 1 interchange;
• Weaving on mainline between Spotsylvania Pkwy and Route 208.</td></tr>
<tr><td>Recommendation for Further Study?</td><td>Drop</td></tr>
</table>

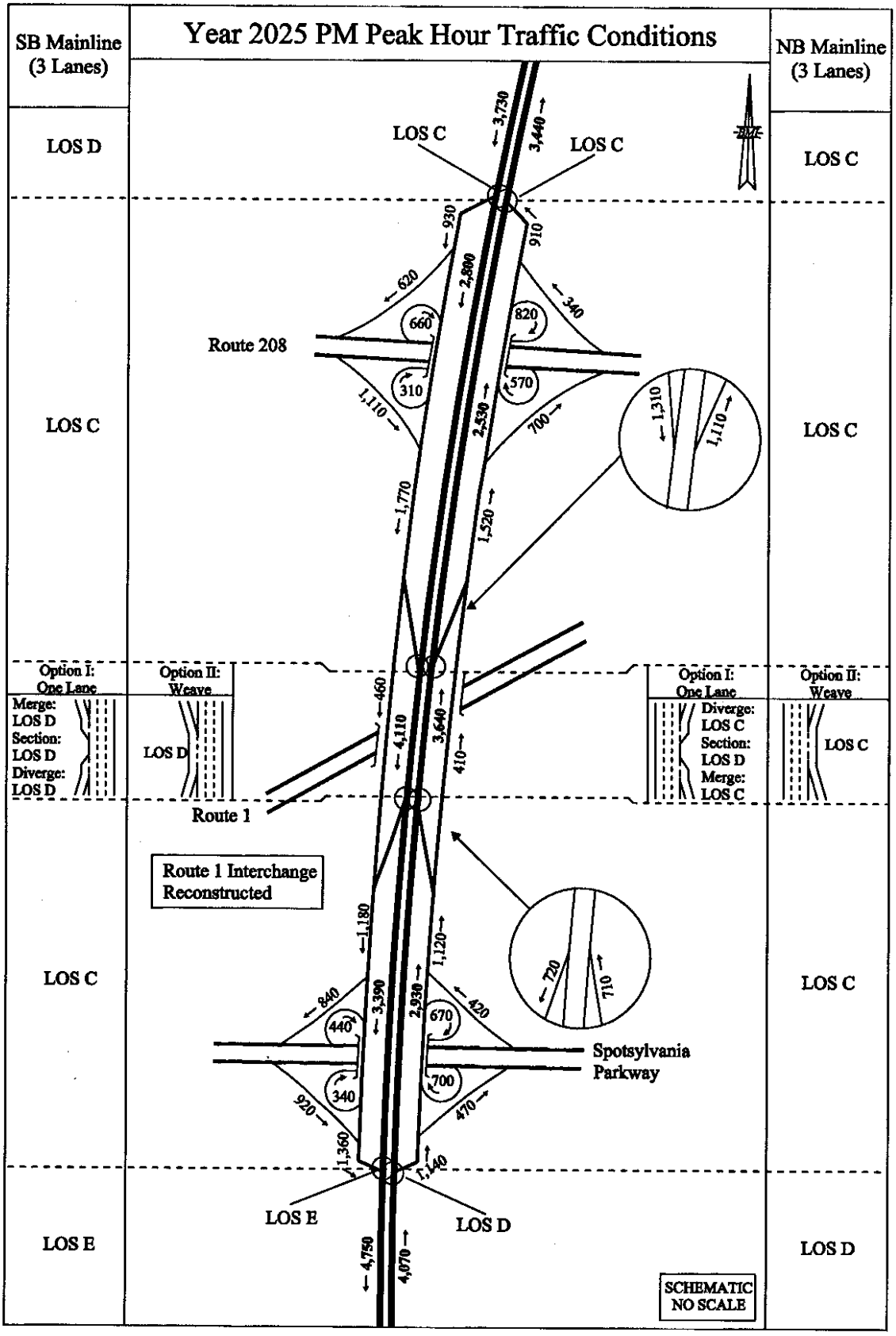


Figure 34. Scenario H-4

Summary for New Interchange Scenarios

With a new interchange at Route 639, Scenario E showed a decrease of 22,400 ADT overall at Route 3(decrease is higher for southbound traffic 34,700 ADT versus northbound traffic 29,100 ADT). Scenario F showed a decrease in overall ADT at Route 3 of 20,000 with a southbound decrease of 31,300 ADT and a northbound decrease of 24,100 ADT. Scenario G showed a decrease of 52,400 ADT overall at Route 3, with a decrease of 33,800 ADT for southbound traffic and 24,200 ADT for northbound traffic. Scenario H showed a decrease of 51,600 ADT overall at Route 3, with a southbound decrease of 35,700 ADT and a northbound decrease of 51,600 ADT. Scenarios E, F and G showed a greater decrease in southbound traffic on Route 3 with a new intersection at Route 639, while Scenario H showed a greater decrease in northbound traffic. Even with a new interchange at Route 639, ADTs did not decrease on U.S. Route 17.

With a new interchange at Spotsylvania Parkway, Scenario E showed a decrease at U.S. Route 1 of 22,300 ADT overall, with a southbound decrease of 16,000 ADT and a northbound decrease of 19,100 ADT. Scenario G showed a decrease at U.S. Route 1 of 28,700 ADT overall, with a decrease of 18,200 ADT southbound and 24,100 ADT northbound. Scenarios F and H do not have an interchange at U.S. Route 1 so there were no overall ADTs calculated. ADTs on Route 606 did not decrease with a new interchange at Spotsylvania Parkway.

Scenarios G and H show a new interchange at Route 208. For these scenarios, the greater decrease in ADT was on U.S Route 1. Scenario G showed a decrease in overall ADT on U.S. Route 1 of 28,700 ADT, with a decrease southbound of 18,200 ADT and a northbound decrease of 24,100 ADT. Overall ADTs are not available for Scenario H because it does not have an interchange at U.S. Route 1. However, for southbound traffic, ADTs decreased by 44,000 and northbound ADTs decreased 40,700.

Overall, there were greater decreases (by almost 50%) in ADTs at Route 3 with a new interchange at Route 639 for Scenarios G and H. Overall decreases in ADT at U.S. Route 1 with a new interchange at Spotsylvania Parkway were relatively equal for Scenarios E and G.

There were decreases in ADT for Scenarios A, B, C, D, I and J. Scenarios A, I and J show a new interchange at Spotsylvania Parkway. Scenarios A and I had overall decreases in ADT at U.S. Route 1 of 22,100 ADT and 28,500 ADT respectively. Scenario J did not show ADTs at U.S. Route 1 because there was no planned interchange. Scenarios B, I and J showed new interchanges at Route 639. Overall decreases at Route 3 because of the new interchange at Route 639 were greater. Scenario B showed an overall decrease of 42,000 ADT, Scenario I a decrease of 52,600 ADT and Scenario J of 51,400 ADT.

The Technical Committee determined that scenario E (new interchange at Spotsylvania Parkway and U.S. Route 1 interchange improved) was clearly superior to scenario F (new interchange at Spotsylvania Parkway and U.S. Route 1 interchange closed), which was dropped from more detailed study.

Different design options were developed for the three remaining scenarios. The key findings of this analysis are as follows:

- At least two of the design options for Scenario E would accommodate the projected 2025 PM peak hour traffic volumes at an acceptable LOS.

- Scenario G is the most challenging scenario in terms of accommodating three full interchanges within a short distance on I-95. Moreover, there are adverse community impacts due to the need to procure additional right-of-way in developed areas within the proposed I-95/Route 208 interchange limits. A large portion of an existing park-and-ride lot in the northeast quadrant of the interchange would be impacted.

- Scenario H is the best scenario in terms of geometric design because of the spacing between the Route 208 and the Spotsylvania Parkway interchanges. However, there may be adverse impacts to local businesses along U.S. Route 1 attributable to the closure of U.S. Route 1 interchange with I-95.

The incremental benefits resulting for a third new I-95 interchange at Route 208, in addition to the new interchanges at the new Fredericksburg access and the Spotsylvania Parkway are summarized below:

- Enhanced accessibility from the Route 208 corridor to I-95. Route 208 provides access to the town of Spotsylvania and the Spotsylvania County Battlefield Parks.

- Reduction to the projected year 2025 ADTs on U.S. Route 1 by approximately 6 percent (2,000 vehicles per day) and 18 percent (5,000 vehicles per day) west and east of I-95, respectively.

- Reducing traffic on north-south streets that provide access between Route 208 and Route 3.

- Reducing PM peak hour volumes on the ramps at the I-95/U.S. Route 1 interchange. The large reductions are projected for the following ramps: the off-ramp from northbound I-95 to southbound U.S. Route 1, the on-ramp from northbound U.S. Route 1 to southbound I-95, and the off-ramp from southbound I-95 to southbound U.S. Route 1. Although AM peak hour traffic projections were not developed for the year 2025, it is reasonable to expect that there would be similar reductions for the "mirror" movements in the AM peak hour. The mirror movements would be the on-ramp from northbound U.S. Route 1 to southbound I-95 ramps, the off-ramp from northbound I-95 to southbound U.S. Route 1 and the on-ramp from northbound U.S. Route 1 to northbound I-95.

- Improved accessibility to I-95 from the Four Mile Fork area and development along U.S. Route 1 between Route 3 and the existing interchange at I-95.

It must be noted that this study did not attempt to quantify the traffic effects at locations beyond I-95. Therefore, it is not possible to present estimates of traffic increases or reductions at other critical locations in the highway network that are likely to be affected by the presence or absence of a Route 208 interchange. Those locations include the following:

- Four Mile Fork, which is the junction of Jefferson Davis Highway (U.S. Route 1), U.S. Route 1 Business, and Courthouse Road (Route 208);
- Signal-controlled intersections on U.S. Route 1 between I-95 and Four Mile Fork; and
- Intersections on Route 208 at Leavells Road and at Smith Station Road.

Neither did the study attempt to estimate the PM peak hour directional thru volumes on the crossroads. Therefore, it was not possible to quantify the effects of the Route 208 interchange on thru traffic on U.S. Route 1 at the I-95 interchange.

The results of this traffic study indicate that, without improvements to existing interchanges or the provision of new access on I-95 in the greater Fredericksburg area, significant levels of congestion will occur on I-95 and cross roads that intersect I-95. By the year 2025, LOS F conditions are projected for the PM peak hour on I-95 between Route 3 and U.S. Route 17, at the U.S. Route 17 interchange, at the Route 3 interchange, and at the two signal-controlled intersections of the U.S. Route 1 interchange. The year 2025 projected PM peak hour traffic volumes will exceed the capacity of the following one-lane ramps:

- From northbound I-95 to northbound U.S. Route 17;
- From southbound U.S. Route 17 to southbound I-95;
- From southbound I-95 to westbound Route 3; and
- From U.S. Route 1 to southbound I-95.

It is important to recognize that because neither traffic volumes were projected nor LOS analyses were conducted for the AM peak hour, it is likely that the demand on other ramps, including the ramp from eastbound Route 3 to northbound I-95 would exceed capacity by the year 2025.

Of the four existing interchanges, the I-95/Route 606 interchange experiences the lowest traffic volumes and levels of congestion. Thus, compared to the other interchanges, there is less of an immediate need to improve this interchange. Rather, the CLRP calls for Route 606 to be widened to four lanes (two in each direction of travel) through the interchange area. It is important to note that a large amount of increased development and growth in population and households is forecasted for the area west of Route 606. Widening Route 606 will result in an increase in traffic flow into the Route 606/I-95 interchange area. Thus, interchange improvements need not be considered until after Route 606 is widened. The other four existing interchanges warrant more immediate attention than the Route 606 interchange.

Clearly, there is a need for capacity improvements at the existing interchanges and/or provision of new interchanges in the Fredericksburg area. Capacity improvements could be in the form of improvements to existing interchanges. While the expanded interchanges may result in improvements in the projected levels of service, they will certainly require more right-of-way to accommodate the expanded interchange area, which will, in turn, have an adverse impact on the existing development in the areas. The most notable example is option 3B for the I-95/U.S. Route 1 interchange, which has a large adverse impact on existing development. Capacity improvements could also be in the form of the construction of new interchanges with or without improvements to the existing interchange. The construction of two new interchanges for the new Fredericksburg access and the Spotsylvania Parkway was projected to have the greatest positive effect on traffic-related MOEs. The key MOE was a measure that indicated the amount of daily traffic that would travel on "over-saturated" highway links in the narrow corridor study area. Over-saturated links were roadway segments where the projected ADT was greater than the ADT corresponding to an LOS D maximum daily volume. The narrow corridor study area included all segments of I-95 and 0.5 mile long segments of all crossroads east and west of I-95 within the study area. The table in Appendix B presents the results of this analysis. Beyond the overall ADT-based MOEs, the study did not look at the effects of the new Fredericksburg interchange on either U.S. Route 17 or Route 3.

The provision of the two new interchanges at Spotsylvania Parkway and new Fredericksburg access would have a positive benefit at the U.S. Route 1 interchange. It is projected that U.S. Route 1 would experience a reduction in ADT of approximately 16,000 to 19,000 vehicles per day. The reductions in projected ADTs on Route 3 immediately west and east of the I-95 would be 35,000 and 29,000 vehicles per day, respectively.

As can be seen in Table 12, the scenarios with the lowest number of congested cross-road links and the lowest vehicle miles of daily travel (VMT) on "over-saturated" links are the following:

- Scenario E, which assumes the new Fredericksburg access interchange and the Spotsylvania Parkway interchange; and

- Scenario F, which assumes the same two new interchanges but also closure of the U.S. Route 1/I-95 interchange (i.e., no access from U.S. Route 1 to I-95 and vice versa at the existing interchange location).

Clearly, then, there are traffic benefits to be derived from new interchanges at the new Fredericksburg access and at Spotsylvania Parkway. However, questions have been raised about the relative benefits of incrementally adding a new interchange on I-95 at Route 208. The provision of a Route 208 interchange is projected to increase the number of congested cross-road links and the amount of travel on "over-saturated" links, compared to the scenarios without the Route 208 interchange (i.e., scenarios E and F). This is attributed primarily to the fact that by providing an interchange on Route 208, the projected daily traffic volumes on Route 208 will increase such that they exceed the capacity (i.e., daily volume corresponding to the LOS D/E breakpoint). The relative projected increase in daily traffic on Route 208 is approximately 20,000 vehicles per day west of I-95 and 10,000 vehicles per day east of I-95. However, there

are benefits resulting from the provision of an interchange at Route 208. To estimate the order of magnitude of those benefits, it was necessary to compare between two sets of paired alternatives.

- Scenario E with Scenario G. For both scenarios, new interchanges on I-95 are assumed at the new Fredericksburg access and at the Spotsylvania Parkway and all movements are still possible at the U.S. Route1 interchange. Comparing year 2025 ADT traffic projections for the two alternatives reveals the following. The provision of an interchange at Route 208 is projected to result in a 6 and 18 percent reduction in ADT on U.S. Route 1 west and east of I-95, respectively. If the Route 208 interchange is added, there would be approximately 2,000 to 5,000 fewer vehicles per day traveling on U.S. Route 1. More importantly, the number of daily vehicles entering or exiting I-95 at the Route 3 interchange is projected to decrease from 97,000 vehicles per day to 67,000 vehicles per day as a result of the Route 208 interchange.

- Scenario F with Scenario H. These two scenarios assume that access to/from I-95 at U.S. Route 1 is closed, in addition to new interchanges being provided at the new Fredericksburg access and Spotsylvania Parkway. The addition of the I-95/Route 208 interchange is projected to result in a 6 percent reduction in ADT on Route 3 west of I-95. There would be approximately 4,000 fewer vehicles per day traveling on Route 3. The total daily trips on and off I-95 at Route 3 are projected to decrease from 99,000 to 68,000 vehicles per day as a result of the Route 208 interchange.

Thus, the net effect is that provision of a Route 208 interchange would benefit both the U.S. Route 1 interchange and the Route 3 interchange. Even with a reduction in traffic at the Route 3 interchange, capacity improvements would still be needed at the Route 3 interchange and the U.S. Route 17 interchange. The traffic demands for the following movements are still projected to exceed the capacity of single-lane ramps:

- Southbound I-95 to westbound Route 3;
- Southbound U.S. Route 17 to southbound I-95;
- Northbound I-95 to northbound U.S. Route 17; and
- Eastbound Route 3 to northbound I-95.

Hence, while the volumes would be lower, the need for capacity improvements at the U.S. Route 17 and Route 3 interchanges would continue to exist.

V. CONCLUSIONS

In the greater Fredericksburg area, there are currently four interchanges that provide access to/from I-95. These are at U.S. Route 17 (Exit 133), Route 3 (Exit 130), U.S. Route 1 (Exit 126), and Route 606 at Thornburg (Exit 118). Traffic entering and exiting I-95 at these interchanges as well as total volumes on I-95 has grown rapidly over the past fifteen years. An analysis of current PM peak period traffic volumes revealed that there are several locations that are operating at a less than desirable level of service (i.e., LOS D or worse). While not analyzed as part of this study, traffic count data for I-95 indicates that traffic flows are as high and even higher than weekday PM peak hours at certain hours on Saturdays, Sundays, and major holidays, especially during summer months.

The traffic projections indicate that, without improvement, the peak period traffic demand will exceed the current capacity of one or more ramps at the interchanges at Route 3 and U.S. Route 17 by the year 2025. In addition, without additional improvements at the U.S. Route 1 interchange, the signalized intersection of U.S. Route 1 and the off-ramp from southbound I-95/on-ramp to southbound I-95 is projected to operate at LOS F.

This study investigated two different approaches to combat the growing traffic problems for I-95 in this area. The first approach was to examine improvements to the existing interchanges. The second approach was to identify potentially viable locations and conceptual configurations for new interchanges in the study area.

With respect to improvement to existing interchanges, today's traffic volumes are already quite high. Considering existing traffic volumes and peak hour levels of service, it is clear that the existing interchanges at U.S. Route 17, Route 3, and U.S. Route 1 have greater need of immediate attention to address capacity deficiencies than the interchange at Route 606. For example, the diverge of the ramp from southbound Route 3 to westbound Route 3 was calculated to be operating at a failing LOS during the current PM peak hour.

Providing C-D roads will facilitate mainline flow at congested interchanges by moving traffic volumes that enter and exit at multiple points and weaving volumes from the mainline to the parallel roadway. It should be clearly understood that the primary function of an interstate freeway is to serve through travel, not local access. Consequently, reducing access points and removing weaving sections from the freeway mainline greatly facilitates flow. The C-D road at the U.S. Route 17 interchange provides an excellent example. Traffic flow on the mainline of I-95 is noticeably better in the northbound direction compared to the southbound direction. It can be argued that providing C-D roads at congested cloverleaf interchanges is one of the most effective ways to get immediate relief for the mainline.

It is important to recognize that the provision of C-D roads within interchange areas and between interchange areas is not likely to result in a redistribution of traffic volumes. Congestion problems can and will still occur at ramp terminals on the crossroads.

This study determined that there are several existing interchange improvement concepts that could be implemented to improve the projected PM peak hour LOS. Without the provision of additional new interchanges, the analysis of year 2025 traffic projections revealed that several ramps would need to be widened. In addition, at least two loop ramps should be replaced with direct-connect ramps with improved geometry. The results also indicate that C-D roads within and between the U.S. Route 17 and Route 3 interchanges would have very positive traffic operational benefits.

The study also identified at least three potential improvement concepts that would improve projected traffic conditions at the I-95/U.S. Route 1 interchanges without the introduction of new interchanges elsewhere in the corridor. All of these would require expanded interchange footprints, which would have a negative impact on adjacent existing development in the immediate interchange area. A more detailed study of these options is warranted.

At the Route 606/I-95 interchange, there is not an immediate need for improvements. However, after Route 606 is widened to four lanes in conformance with FAMPO's constrained long-range plan and after the forecasted development west of I-95 has occurred, then traffic at the Route 606 interchange is projected to increase to a point where interchange geometric improvements will be necessary in the future. One promising concept to address the projected traffic increases was developed for this study.

Regarding new access to I-95 in the Fredericksburg area, several of the new interchange scenarios are feasible from a traffic/engineering/ environmental impact perspective and should be advanced for further study. Table 29 presents a summary of new interchange options recommended for further study. The table shows the estimated acreage that would be required for additional right-of-way. They are based on county-series property maps and an assumption that right-of-way would be required for a distance of 50 ft beyond the edge of the shoulder on all outer ramps. Similarly, the construction cost indices are order-of-magnitude, relative measures that are consistent with planning level feasibility analyses and do not reflect the costs for additional right-of-way. The environmental overview for the new interchange scenarios identified no "fatal flaws" that would preclude construction of recommended improvements. Table 29 presents information the overview developed on potentially affected acres of wetlands and floodplains. The next step would require more detailed assessment of the built environment and detailed field survey work. Finally, the last column of Table 29 presents a traffic-based measure that indicates daily vehicle travel projected to occur on I-95 and cross road links in the study area that would be beyond LOS D conditions. The higher the number, the worse the traffic conditions are. While the level of analysis involved in a feasibility study does not provide the amount of detail needed to choose the best option, design option E1 is the most promising based on the review of this study's analysis.

An important point to remember about new interchanges is that they can be very costly and frequently require additional improvements to the existing highway infrastructure (e.g., widening of the cross road on the approach to and through the interchange area). There is usually a significant amount of intense development at interchange locations that will be impacted and add substantially to project cost. When available funds are limited, it is far more challenging to justify and construct new interchanges.

Table 29. Summary of New Interchange Options Recommended for Further Study.

Scenario	Design Option	Right-of-Way Affected (Acres)	Construction Cost Index[1]	Environmental Assessment-Potentially Affected Area (acres)[2]		Projected Daily Vehicle Miles of Travel (DVMT) on Over-Saturated Links in the Study Area (in 1,000 veh-miles/day)
				Wetlands	Floodplains	
E	**E1**	93	34	-	-	56
	E4	152	71	1.2	3.6	56
	E5	141	60	1.1	1.8	56
G	**G3**	221	99	1.5	4.8	79
	G4	228	99	1.5	4.8	79
H	**H2**	163	89	-	-	86
	H3	162	77	-	-	86

[1] Construction Cost Index is a measure to assess the relative difference in construction cost between and among alternatives. It is based on a weighted combination of estimated additional pavement and bridge structure areas for each alternative.

[2] Note: Estimates of impacts are not used for engineering purposes. Data sources are of varying accuracy and final impact determinations may be different.

In conclusion, this study identified improvements to existing interchanges and viable locations for new interchanges. More detailed traffic study, as would be typically conducted as part of an interchange justification study required by FHWA, and environmental analysis is needed. For this feasibility study, the objective was not to endorse one approach over another (i.e., improvements to existing interchanges vs. construction of new interchanges). Rather this study was aimed at determining if either approach was feasible. Resource availability, among other factors, needs to be considered carefully before further decisions can be made.

VI. PUBLIC COMMENT

A public involvement program was developed in April 2000 to supplement the goals of the I-95 C-D Access Feasibility Study and the I-95 Extension of HOV Lanes Study.[1] The specific objectives of the program were to:

- Create public awareness of the purpose and scope of the project;
- Solicit input from citizens on issues and developments relevant to the scope of the project; and
- Report study results at key milestones.

Program activities were proactive, informative, and solicited broad input from citizens, elected/ appointed officials, communities, interest groups, and agency representatives. The major components of the public involvement program are discussed below.

Public Involvement Activities

Developing a list of stakeholders was one of the first activities with which the public involvement team was involved. The team researched and identified potential stakeholders who worked in, resided, or commuted through the study corridor. Stakeholders who represented interested/affected constituencies who travel through this corridor were also included. The names and addresses of these key stakeholders were compiled into a mailing database of approximately 500 persons/agencies. It was anticipated that many of the stakeholders would represent their organizations and act as conduits by advising the study team of issues that should be considered within the studies' scope and by communicating findings back to their respective organizations. Key stakeholders included representatives from the following groups:

- Elected and appointed officials from Stafford and Spotsylvania Counties and the City of Fredericksburg;
- Federal, state, and local agency representatives within the study area;
- Business, environmental, community, civic, and homeowner organizations;
- Transit providers and patrons (private bus operators, rideshare coordinators, and VRE);
- Current/potential/non-HOV users;
- FAMPO and RADCO members;
- Local media (newspaper, television, and radio);
- Slugs (the term applied to commuters who carpool to and from work with different drivers on a daily basis);
- Virginia State Police; and
- Major employment centers.

[1] A separate report*, I-95 HOV Feasibility Study*, documents the results of the study on the feasibility of extending the HOV lanes to the Fredericksburg area.

The stakeholder database was used to invite citizens to public information meetings. These citizen meetings were held on July 27, 2000 and October 29, 2001. The first meeting was held in the early stages of the studies and the second was conducted towards the studies' conclusions. The general public, as well as the invited stakeholders, were welcome to attend the meetings. In addition to the personal invitations mailed to all stakeholders on the mailing database, the team prepared meeting notices for the project website (www.virginiadot.org), newspaper ads, and press advisories.

At the public meetings, the study team distributed informational materials, which included the agenda, an overview of the presentation, fact sheets, and comment forms. Citizens had ample opportunities to ask questions, provide comments, complete comment sheets, and view study-related exhibits and maps.

Many of the questions and comments from the first meeting focused on the HOV lanes, particularly the number of HOV lanes, extension of HOV lanes to Prince William County, the application of Intelligent Transportation Systems (ITS) with HOV lanes, whether the lanes would be HOV-3 or HOV-2 or concurrent versus barrier-separated, and the related safety and enforcement issues associated with HOV lanes. Several citizens also asked questions about local transportation projects.

At the second public meeting, many citizens' questions and comments related to the C-D Access Study–specifically the parcels that would be impacted, the width of the C-D roads and the impact on the shoulders to I-95, elaboration on the screening process, and the value of adding more through-lanes versus C-D roads.

Other communication methods used for these studies included the project website, which presented a description and location of the studies, contact information for the VDOT project manager, a calendar, and a status of the study. A toll-free hotline (1-800-862-1386), maintained by VDOT staff, was also employed during the course of the studies.

Citizen Comments

The following are comments, both from the comment sheets and via e-mail received from the two public information meetings. They are primarily concerned with the C-D Access Study and some overall general comments. The number to the left of each comment refers to the number of times that specific comment was made.

Comment Sheets

What concerns do you have with any of the suggested new interchanges or existing interchange improvements? What other concerns do you feel need to be further addressed?

1 The C-D Access and HOV lanes are essential for the mass amount of growth here, as well as in the south, east, and west.

1 The new Spotsylvania Parkway interchange is needed now. However, the current northbound access to U.S. Route 1 should be maintained. Specific information is needed on bridges or bridge expansion over the river.

1 C-D roads should have been built yesterday before so much growth. 6-year increments are passé.
1 C-D roads are needed from Route 3 South to U.S. Route 1.

What other concerns do you feel need to be further addressed?

1 Any expansion of I-95 must include very wide shoulders such that bridge maintenance can be done with no impact on travel lanes.
1 Cost estimates of the study should be made available to the public including both the contractor cost and VDOT staff cost.
1 Public employees and agencies must understand the need for full accountability to the citizen.
1 My State Route 638 fronts I-95 and has 3 business entrances off it. All are C-2 zoned.

E-Mail

C-D Roads

1 Is there consideration for C-D roads on Route 610 and Route 630 exits?
1 Status of C-D access roads from Stafford to Spotsylvania.
1 Request to review study documents.

Other Comments

1 The I-95 Study will make the region more mobile and connected.
1 The I-95 Study tended to focus not so much on the region mobility as protecting the I-95 mainline.

Other Studies/Areas

1 Request information on construction work at Quantico.
1 Concerned that Outer Connector does almost nothing to relieve congestion.
1 Concerned that ramps at Route 3 and U.S. Route 17 will only get worse with ongoing settlement.
1 Request for traffic data information.

Project Status

5 What phase is the project in; is it complete?
4 General project status (timeframe).
1 When will public comments be taken and public meetings be held?

Support C-D Lanes

1 What we need is C-D roads with slip ramps from interior roads, not interchanges.
1 Without C-D roads, not only will congestion get worse on the primaries but also I-95 will become virtually impassible at peak hours and on holiday weekends.

1 C-D roads must be employed to disperse the traffic to non-primary access points.

Single Point Urban Interchanges (SPUI)

1 Were Single Point Urban Interchanges (SPUI) considered as opposed to cloverleaf interchanges?

1 SPUI are superior to cloverleafs in areas with heavy traffic and limited footprint availability.

APPENDIX A

Traffic Data Collection/Analysis

APPENDIX B

Traffic Projections for Year 2025

APPENDIX C

Color Drawings of Scenario Features